EDITORIAL

HAVING failed to make the payment due on April 1, the deal for the purchase of the Union Oil Company by the Weir syndicate has been formally declared off. Whether negotiations will be resumed after the close of the War remains to be seen, but the probabilities are that for some time to come America will have to finance Europe, rather than the reverse.

IMPROVEMENT has been manifested in the California oil situation, as is indicated by the field report for March. While the daily average production was approximately the same as that for February, the daily consumption was 22,000 barrels greater, and only 17,000 barrels less than that for the same month last year. The total excess of production over shipments during the month was 93,000 barrels.

MAY 5 is the date for the formal opening of the Columbia River canal from The Dalles to Celilo. This removes the last obstacle to navigation at ordinary stages of water between the mouth of the river and Priest Rapids, Washington, on the Columbia, or Lewiston, Idaho, on the Snake river. Work on the canal, which is 8½ miles long, commenced in 1905 and cost $4,850,000.

ANNOUNCEMENT has been made by the Department of the Interior of the route for the Government railroad in Alaska. The line will extend from Seward on the coast in a generally northerly direction by what is known as the Susitna route to Fairbanks, a distance of 471 miles. The Alaska Northern railroad has been purchased and will form the first 72 miles of the system. A branch 38 miles long will be run to the Matanuska coalfield. The total cost of the road is estimated at $26,800,000, and it is expected that about forty miles will be completed this year. The present policy in handling the construction work is to let the work in comparatively small sections to individual contractors.

WANTED, an engineer for highways in Kings county. This is not an advertisement, but is merely a suggestion. A bond issue for road improvements is up for consideration by the voters on May 6. The specifications call for a type of road surface totally unfit for the character of material of which the sub-grade is composed. Competent engineers have expressed the opinion that the life of the proposed surface will not exceed 10 years at best, with the probabilities placed at about half this amount. The bonds are for a 30-year period. Further comment seems unnecessary, except to remark, in passing, that there is no duly constituted road engineer on the staff of the Kings County Highway Commission.

"LO, the poor Indian" is fast becoming an obsolete saying. Good roads, which may be taken as the surface indication of culture at depth, are more than a mere white man's craze. The Indians at the reservation near Portersville have been uncomplaining for years at the wretched state of the highways between their district and the town. Now, however, their patience has become exhausted, and failing to obtain consideration at the hands of the county officials, they have taken the matter into their own hands. A crew of volunteers is busily at work reducing grades, eliminating river crossings, and re-surfacing as fast as they can. Their enterprise is commendable and merits the co-operation of their neighbors.

GAS RATES in Los Angeles have been a frequent cause for comment in this journal. The situation in which the Midway Gas Company found itself by reason of the arbitrary and unreasonable action of the City Council in establishing a 40-cent rate excited our sympathy. Now comes Mr. William Mulholland, advocate of municipal ownership and all that sort of thing who, having completed an appraisal of the companies' property in behalf of the city fathers, has presented a report indicating that 70 cents is the rate that should obtain. Will the City Council heed the report of a competent engineer, obviously free from bias in favor of any corporation, or will it again disregard what it should have known in the first place and continue the 40-cent rate in force?

PIECE-WORK is the bone of contention over which employers and employees almost invariably disagree. On the employers' side, the disinclination to pay for anything they do not get is natural; on the employees' side, it has been contended, unfortunately often with truth, that the maximum output of yesterday is made the minimum output for to-day, with the result that the men have been frequently forced to overtax their capacity by the driving methods of superintendents and foremen. One of the many economic wrongs that have been perpetrated by the trade unions as a sort of counter-attack against the piece-work system has been and is limiting the output, in other words, adopting as a standard of individual daily production something less than the capabilities of the least skilled man in the shop and compelling the better workmen to work down to the lower standard. This has been particularly true in many of the California foundries, which has resulted in costs so high as to make it almost impossible for the local iron works to compete for national trade. There ought to be a middle ground of compromise upon what may be reasonably determined to be a genuine day's work,

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granting an adequate bonus to workmen for any output above the established standard. In order to make this effective, the employees should be guaranteed that there will be no departure from the established minimum, in order that they may feel protected when endeavoring to profit by their individual skill and proficiency. A bonus system somewhat along these lines is in use in some communities in connection with the relations of the public service corporations to the general public. By reason of the power given to the Government to regulate rates, the dividend rate for a corporation, such as a gas company is prescribed, together with a price per thousand cubic feet of gas. On the other hand, if the company is able to improve its methods in any department, thus lowering costs, the increased earnings due are permitted to be applied to an increase in the dividend rate. Thus the maximum rate per 1000 cubic feet of gas is fixed, regardless of the dividend rate. It is recognized that in order reasonably to expect improvements in service or cost, an incentive must be provided. This is equally true in the case of both employer and employee. The employee cannot reasonably be expected to do better work unless he is compensated for it, nor can the employer be expected to improve his service or methods of manufacture, when at the first sign of such improvements, the rates that he is permitted to charge will be lowered by some public utility commission, so that the consumer will be the only one benefited by the improvement. In other words, it is a poor rule which does not work both ways. Improvements of any sort that could be inaugurated by any public service corporation might, with reason, be shared equally by the stockholders, employees, and consumers, and not, as under present-day methods, be extended to the employees and consumers only.

RESTRICTIVE legislation and regulation of large enterprises by the Government has made it more than likely that in future many great projects must be taken up by the Government itself, as capital is indeed timid under present conditions. That this is true in Canada as well as in the United States is shown by the course pursued by the Canadian government in the case of the Grand Trunk Railroad. The Government has completed a railroad at a cost of $172,000,000 from Moncton, New Brunswick, to Winnipeg, Manitoba, a distance of 1800 miles. An agreement was consummated between the Government and the Grand Trunk Pacific Railroad whereby the latter was to take over the road on a 50-year lease, paying therefor a rental of 3 per cent on the cost of construction. Now the Company has refused to carry out the agreement, alleging that certain work about the terminals has not been completed as specified. This however, is regarded as a pretext, and much doubt has been cast as to the possibility of the road being made to pay under the terms of the lease. The only recourse for the Government is to operate the road itself. This would be interesting indeed, especially to the advocates of Government ownership in this country, provided accurate cost records are kept.

Concrete Roads

In the case of concrete roads, as in every other kind of engineering development, the first problem was to learn how to make them, and the second to learn how to make them cheaply. It has taken some years to accomplish the former, while the day of the cheap concrete road seems to have arrived. Wayne county, Michigan, appears to have been the pioneer in concrete road construction, and the results obtained there have been a frequent matter for comment in the columns of this journal. The action of the California State Highway Commission in adopting a concrete base for the greater part of the new state highway is, of course, well known, the results on the first section to be thrown open to traffic having been made public in our issue of January, 1915. It is not surprising, therefore, that concrete-base streets are coming into vogue, not merely on the main arteries that carry the bulk of the city's traffic, but in the outlying districts as well. The State Highway Commission, it will be remembered, adopted a 4-inch concrete base as a foundation, this character of construction being as nearly permanent as it is possible to make it. The wearing surface consists of a so-called paint coat of asphaltic oil upon which rock screenings are sprinkled and rolled. Thus when additional funds are available, an asphalt surface of whatever thickness is desired may be placed upon the concrete foundation. In this way, none of the initial investment is lost. The permanent foundation is always ready for a top-coat, if desired, while in the case of water-bound macadam four or five years would be a most unusual life if the pavement were at all subject to motor traffic. It is interesting to note, not merely the increase in the use of concrete-base streets in the larger cities, but also its adoption in the smaller towns as well. This is as good an indication as any that thought and progress are by no means confined to population centres. Only a few weeks ago, the city of Portersville adopted a comprehensive plan for better streets, a contract having been let to the Federal Construction Co. at a price of $0.1283 per square foot for 5-inch concrete base with a Topeka top; contracts were also let in San Bernardino last October at a price of 10 cents per square foot for streets having a 4-inch concrete base with an asphaltic-oil wearing surface. A cost apparently lower than either of these is that of 11.7 cents per square foot for 4-inch concrete base with 1½-inch Topeka top, contracts at this price having been let at Pomona last November. At Walla Walla, Washington, this month, contracts were let for 4-inch concrete base with ½-inch bituminous top at prices as low as $0.89 per square yard. It would appear from this that a 4 or 5-inch concrete base could be obtained at prices of about 9 to 10 cents per square foot if contracts were let for reasonably large quantities. These costs are little, if any, higher than those previously obtained for much lower grades of pavement, thus indicating that the second stage in concrete road and street construction seems to have been reached, namely, the stage at which first-class work can be done very cheaply.

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REVIEW OF THE MONTH

ONE of the interesting possibilities found in the pending suit brought by the Government to unmerge the Central and Southern Pacific Railroads lies in the fact that, should the Government prove successful, the latter company will be left without rail connection between Tehama, California, and the Oregon line. Here is one of the many idiosyncrasies to be found in the early history of railroad building in California, this particular section of road having been built by the Central Pacific Railroad. Under these circumstances, speculation as to other possible routes over the Siskiyou mountains is of interest. The grades are unusually severe, and it is not unlikely that a better route may be located than that now in use.

SOME time ago, the California & Oregon Coast Railroad was incorporated for the purpose of constructing a road from Grants Pass, Oregon, to Crescent City, California. Ten miles of this road, from Grants Pass to Wilderville has been completed, while on the Crescent City side another ten miles has been built to Smith river. From this latter point surveys have been completed to Wilderville, a distance of 71 miles, and no great constructional difficulties have been encountered. Two summits will be crossed, one 1650 and the other 1950 feet elevation, the maximum grade being 2 per cent and maximum curvature 10 degrees. This line will tap a region of great possibilities in mining, lumbering, and agriculture that has thus far been undeveloped due to lack of transportation facilities. It has been reported that Twohy Brothers of San Franciso have become interested in the road and that they will commence construction work during the coming summer. That the road, if built, will be taken over by the Southern Pacific Company is at least within the range of possibility.

TRINIDAD is a short distance north of Eureka and the most northerly point on the Northwestern Pacific system, the distance from Crescent City being about 75 miles. With the railroad already in existence from Grants Pass, it would be a simple matter to continue along the coast to Trinidad. Thus the Southern Pacific company would have another through-line from Portland to San Francisco in case the Government contention in the pending suit is upheld, while the summit would have an elevation 2000 feet lower than that on the route now in use. This would also greatly benefit the Northwestern Pacific, as, under present conditions, the recently completed extension to Eureka will not return interest on the investment for some years to come, while, as an integral part of a through-line between San Francisco and Portland, its possibilities as a dividend payer would be infinitely brighter.

RESIDENTS of the district tributary to the Salt River reclamation project have every assurance that for the season of 1915 an ample supply of water will be available. The main reservoir is full and water is flowing over the spillways of the Roosevelt Dam. This overflow is not being wasted, however, as the irrigation season is now well under way. Officials of the Reclamation Service have calculated that in addition to its stated capacity of 1,367,300 acre feet, an additional amount of 51,000 acre feet is flowing between the upper intakes and the spillways.

AS has been recognized for some time, the $18,000,000 bond issue voted in 1910 by the people of California will not provide sufficient funds for the completion of the entire state highway project to the extent that is admitted to be essential to provide an adequate system. The State Highway Commission has now recommended the issuance of $12,000,000 additional bonds, bringing the grand total up to $30,000,000. The Commission has expressed the opinion that by using convict labor on the mountain laterals, the entire system of something over 3000 miles can be completed for this amount. While the people have recently manifested a disposition to reject additional bond issues for civic and state improvements, everyone recognizes the great advantages that accrue to a state possessing an effective system of good roads. The excellent standards established by the present commission and its engineering staff should be strictly adhered to, however, and no departure from these should be permitted under any circumstances.

IN a report recently issued, the California Railroad Commission shows that the public service corporations of this state were authorized to issue $226,725,501.98 in securities during the year ended December 31, 1914. Of this amount $155,116,368.82 represents improvements for steam and electric railroads; $59,140,387.98 for gas, electric, and water companies; $182,345.18 for telephone and telegraph companies; and $11,286,400 for warehouse, pipe-line, and car companies.

CONSERVATION with respect to the public lands is again under fire. The Wyoming legislature has passed resolutions protesting against both the withdrawals of public land and the leasing system, these being characterized as a "dangerous menace to a republican form of government." It is granted that the theory of conservation is fundamentally sound, and that indiscriminate and sweeping land withdrawals were necessary in order to prevent the wholesale land grabbing that was going on to such an extent that within a comparatively short period, the best part of the United

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States would have been in the possession of a comparatively few individuals. It appears on the other hand, that the Government has been painfully slow in devising adequate measures for the development of our public lands and mineral resources by individual locators, and that until some rational method is adopted, development will be at a standstill. The Geological Survey, the Land Office, and the Bureau of Mines are doing the best they can with the limited force and appropriations at their disposal, and, if given the authority plus an adequate staff, all of the public lands could rapidly be classified and placed open to entry on some leasing system. If some of the many useless commissions appointed by Congress to examine into all sorts of inconsequential things could be eliminated, the money saved could be applied to the three bureaus mentioned above to excellent advantage.

NO leasing system can be devised that will be satisfactory to everybody. The old application of the placer-mining law to oil land has been subject to so many abuses as to leave it in a defenseless position. Nevertheless, many are violently opposing any leasing system, while at the same time are offering no alternative with which they will be satisfied. However, whether it is liked or not, there is no doubt that a leasing system of some sort we are going to have, as far as oil land is concerned, so those opposed may just as well adapt themselves to circumstances and go to work.

FOLLOWING the course laid out by the Standard Oil Company, the General Pipe Line Company has, under protest, filed a schedule of rates with the California Railroad Commission in accordance with the provisions of the so-called common-carrier pipe-line law. The other pipe-line companies have appealed to the State Supreme Court to intervene, while in the meantime the Commission has given them to understand that they will be protected in the event of their being called upon to transport oil in excess of the capacity of their lines. Protection is also to be extended in the case of oils being offered for shipment of different gravity than that for which the pipe-lines have been designed. These assurances in themselves are sufficient evidence of the radical defects in the law, the incongruities in which having been repeatedly pointed out in these columns.

CONTRACTORS for municipal work will be greatly interested in the decision recently rendered by the Superior Court in Santa Clara county. A resolution of intention for the improvement of a certain street had been issued providing, among others things, for the installation of corrugated culverts. After due publication of the resolution, the Mayor, Common Council, and contractor agreed that the culverts were not to be installed. After completion of the work, certain of the property owners refused to pay their assessment for the improvement. In due time, recourse was had to the courts, with the result that the court decided that as the work had not been performed according to resolution of intention, the property owners were not liable. Moral: municipal business is different from that between private parties, and it is a wise man who in dealing with the Government in any form, adheres firmly to the letter as well as the spirit of specifications.

BONDS in the amount of $1,250,000 for road improvements have been approved by the voters of Multnomah county, Oregon. The proceeds of their sale will be used for paving 70 miles of roads, including the famous Columbia highway.

ONCE more the voters of San Francisco have declined to purchase the Spring Valley Water Company's properties. Reasons why the project failed to receive the necessary two-thirds majority seem lacking beyond the possible effect of the opposition of some of San Francisco's labor leaders. Municipal ownership of public utilities has thus far been successful in San Francisco, if the street railways can be accepted as a criterion. The reasons for this success may be found more in the muddle made by the United Railroads in the conduct of their affairs than in any special merits in municipal ownership *per se*. In analyzing the failure of the Spring Valley project, however, it would appear to a casual observer, that the first reason was that of price and the second that of a lack of understanding by the voter of the economic reasons for the purchase. Corporation baiting has become almost a habit, and a senseless one. Many voters were so obsessed with the view that this measure was intended as a sort of gigantic Christmas present for the Spring Valley company, that they entirely overlooked the issue of paramount importance; that of providing the city with a bountiful supply of fresh and pure water before its absence commenced to have a more marked effect upon the city's growth. The proponents of the measure showed a singular lack of skill in presenting the issue clearly before the people, in fact a lack of effective organization has been evident from the start. Opponents, on the other hand, made much capital out of the insinuation that information was being held back, while the quiescent attitude of the advocates of the scheme lent color to this assumption. However, there is no use in crying over spilled milk. The Spring Valley properties must be purchased by the city in order to validate its rights to the Hetch-Hetchy source in accordance with the grant made by Congress. Now that the proposed bond issue has failed, wearisome condemnation proceedings will be the next step, with whole schools of lawyers, experts, and what not on the payroll. After the case has dragged its weary way from court to court, the taxpayer in the meanwhile having to pay the bill, the city will have the melancholy satisfaction of having 'rebuked' the grasping monopoly, delayed development of the outlying districts over a term of years and thereby achieving the ultimate result of paying out an amount in the aggregate probably much greater than the price at which the properties were offered.

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Port-Terminal Improvements on the Pacific Coast—Part II

By PAUL WHITHAM*

[EDITOR'S NOTE.—This is the conclusion of Mr. Whitham's article, begun in the April number.]

Detail Improvements

It was pointed out in Part I that docks and wharves are mere details in the general harbor scheme. If the general scheme is poorly planned it affects the efficiency of every dock warehouse, railway, or other facility constructed in accordance therewith. Furthermore, after improvements have been made, it is difficult, if not impossible to correct the errors in the fundamental plan. On the other hand, if the general plan is right, errors in the construction of a particular dock,

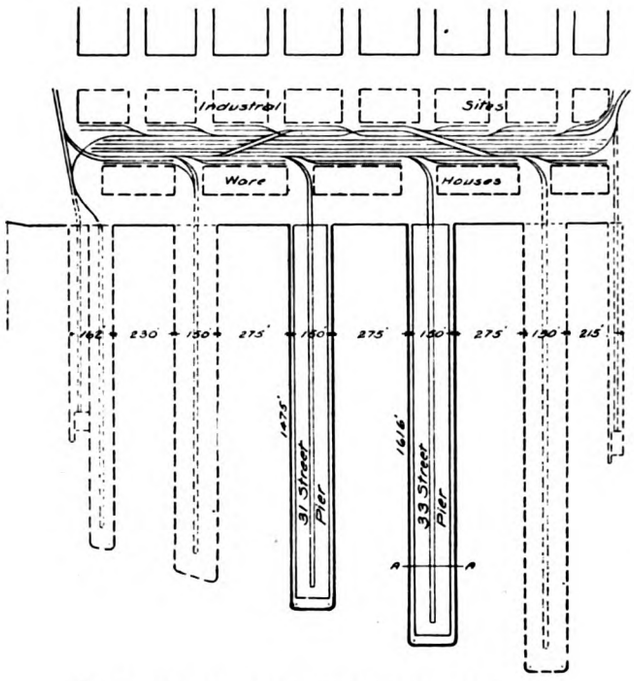

FIG. 1. GOWANUS BAY IMPROVEMENT, NEW YORK.

while seriously affecting the efficiency of that unit, do not materially affect the scheme as a whole.

While they may be mere details, wharves and piers are very important factors in the terminal scheme and the great cost of the larger units, frequently running into the millions, emphasizes the importance of great care being taken in their design. Preliminary to a description of the recent dock improvements on the Pacific coast, it may be well to outline in a general way the tendency of modern practice in dock and warehouse design.

The character of a dock or wharf structure is, of course, determined in a large measure by the class of traffic it is intended to handle. Outside of special traffic structures, such as coal and ore docks, there are three principal classifications:

(*a*) Over Seas Docks.
(*b*) Local Freight and Passenger Facilities.
(*c*) Industrial Wharves.

(*a*) Over Seas Docks

The modern tendency is to group deep-sea docks so that a number of piers are joined as one physical and

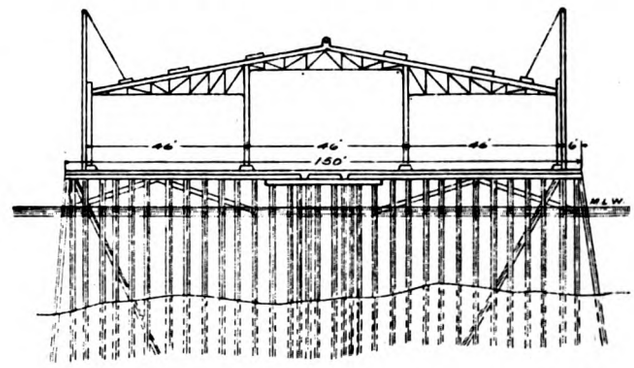

FIG. 2. CROSS-SECTION A-A, GOWANUS BAY IMPROVEMENT.

operating unit. Back of the piers are placed warehouses, grain elevators, and cold-storage facilities, all adequately served with railway trackage and yards, so that without shifting berth a vessel may discharge or load a large variety of commodities. For illustration of the terminal group scheme see the Gowanus Bay terminal, New York, (Fig. 1) also the Tilbury docks, London (Fig 17). The two cases just referred to are

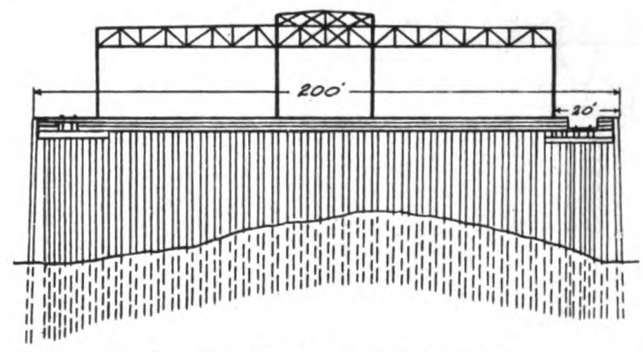

FIG. 3. CROSS-SECTION, SAN FRANCISCO PIER.

typical illustrations showing the differences between English and American practice. Fig. 1 shows the pier or jetty type of improvement which in this country costs from one to two and half million dollars per mile of dock frontage. Fig. 17 and Fig. 18 show the enclosed-basin type of improvement with expensive locks and vertical masonry walls costing from four to six million dollars per mile of dock frontage.

A type of pier construction much in favor here and

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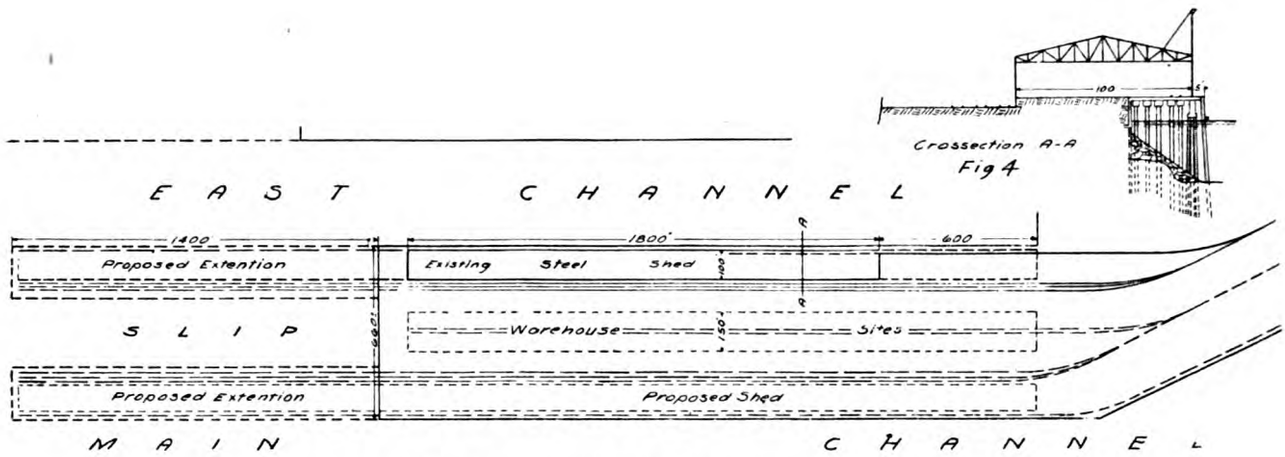

FIG. 4. MUNICIPAL DOCK NO. 1, LOS ANGELES.

abroad is similar in cross-section to that shown in Fig. 6. The essential features of this type are the filled central core, two sheds, one on each side with depressed tracks between them and in most cases a driveway also. Chief among the advantages are better fire protection, adequate railway service and the complete separation of cargoes being worked from opposite sides of the pier.

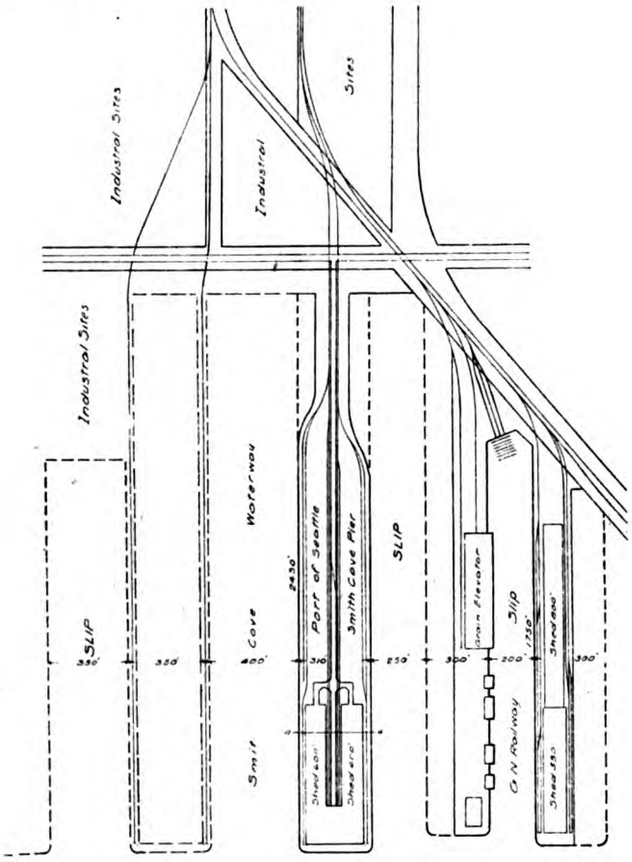

FIG. 5. PORTION OF NORTH TERMINAL DISTRICT, SEATTLE.

The Pacific Coast practice in the matter of rail service to piers and wharves is generally in advance of that on the Atlantic coast. Usually not only are depressed tracks provided in the rear of the sheds, but tracks are provided also on the wharf aprons in front of the sheds for use in direct rail-ship transfer.

In Europe the practice is to build massively of permanent materials. In this country reinforced concrete is being used quite extensively of late, but there is a strong tendency to build of less expensive materials, endeavoring, however, to obtain a structure the physical life of which should be not less than twenty-five years. The sizes and types of ocean carriers as well as the methods of freight handling are changing so rapidly that it is not advantageous to figure on a commercial life for a dock structure of much over 25 to 30 years. Many of the modern wharves are equipped with automatic fire sprinkling systems. Whatever the type of the piers, the tendency is to make both the piers and slips wider. The increase in the size of ships has had a good deal to do with it, but even where the slips are used by comparatively moderate sized vessels the advantages of having ample maneuvering room in the slips is proving worth the area so occupied.

Mechanical equipment for handling package freight at port terminals, while in general use in Europe, is little used in this country. Fig. 22 illustrates the type of dock crane so common in Europe, while Fig. 2 and Fig. 4 show the dock mast as developed at New York and adopted at Los Angeles, California, and Portland, Oregon. The dock mast seems to be giving good results where the shed is close to the fender line and it is necessary to whip the sling into the doorway. The masts are used to support tackle operated either by the ships or dock winches. In a few instances telpherage systems have been installed, but without marked success. Electric driven dock trucks are proving more or less successful where the trucking distance is considerable. As a matter of fact, however, very little progress has been made in the handling of mixed cargo by mechanical means. It is difficult to answer the question why dock cranes of the European type are not used in this country. Steamship companies which use the cranes at their European terminals when given their choice have refused to have them installed at their American docks. A great deal of thought is being

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given to the cheapening of cargo handling at terminals so that it is safe to predict that many of the methods

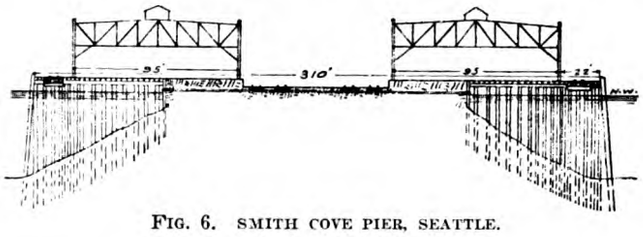


FIG. 6. SMITH COVE PIER, SEATTLE.

will be improved upon within the next few years. The attitude of port authorities on the Pacific coast seems to be one of 'watchful waiting' in this regard.

(b) Local Freight and Passenger Facilities

The local conditions at each port have greater influence on the design of such structures than in the case of deep-sea docks. The passenger docks usually have two-story sheds requiring ramps and elevators or other means of communication between the two floors. The safeguarding of human life is a prime factor in the design of such structures. The waiting rooms are frequently placed in fire-proof head houses even though the outer portion of the pier is of timber construction.

Each local freight and passenger dock is a special case in itself, so that it is not practical to try to point out very much as being general practice. A grave mistake is frequently made, however, by considering local landings, particularly for small boats, of subsidiary importance when, as a matter of fact, the accumulated affect of the good or bad design of a large number of such structures, has a very important bearing on the cost of doing business in the port.

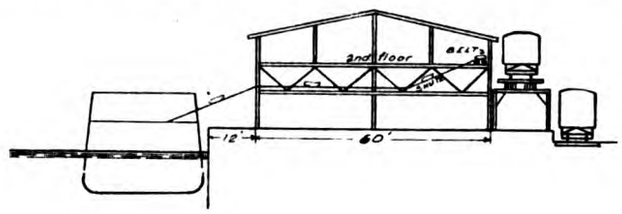
(c) Industrial Wharves

These include a large range of special structures, from a little sand and gravel dock to a big million dollar ore dock adjoining a steel plant. It is in the field of handling raw bulk materials for industrial uses that America has set the pace in the development of economical handling equipment. In every important industrial district one or more public industrial wharves or landings should be provided to serve industries not directly situated on the waterfront. Such structures are usually uncovered, but equipped with derricks or other rigs designed to assist in unloading barges and lighters.

Important Docks Recently Constructed at Pacific Coast Ports

Port of Seattle.—The port of Seattle as a public corporation was organized a little over three years ago. It was authorized by the voters of the district to spend altogether six million three hundred thousand dollars for docks, warehouses, and landings. The program it outlined will be fully completed during the autumn of this year. A number of the improvements are now about completed and partly in service.

As described in part I, there are two terminal districts in Seattle and the greater portion of the improvements having been made in these districts, in the construction of facilities to accommodate deep-sea shipping. Following the example of practice in the older communities, it was decided to obtain sufficient property at each site so that warehouses and other storage buildings might be erected adjacent to the wharves and docks. At some of the sites the warehouses are now completed or under construction. At other sites the property is being held in reserve so that the warehouses can be constructed when the need arises. The policy adopted in the construction of wharves is to support them on creosote piling, the sheds to be of slow-burning type, covered with galvanized iron. The sheds are all being equipped with automatic sprinkling systems. It is estimated that with some slight repairs the docks will be good for at least twenty-five years, which is about the limit of the commercial life of structures of that class. The cost of



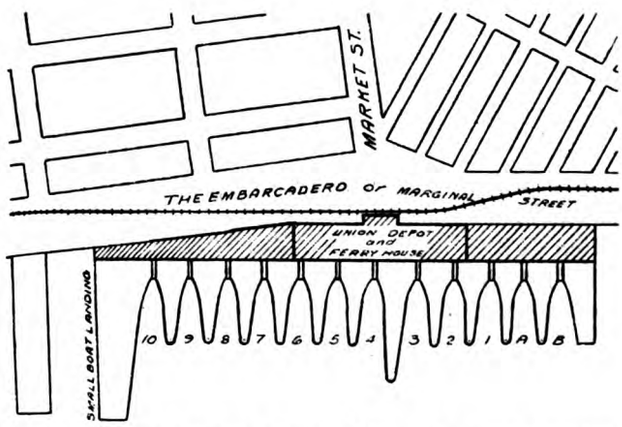


FIG. 9 AND 10. WHARF AT FORT WILLIAM, AND FERRY TERMINAL AT SAN FRANCISCO.

these structures is less than one-half what they would cost in concrete of the most economical type.

The warehouses are all reinforced concrete structures, thoroughly fire-proof and equipped with sprinkling systems to protect the commodities in storage. Adjacent to one of the docks a 500,000-bu. grain elevator is nearing completion and is so arranged that the storage capacity can be readily increased to 1,000,000 bushels. These several warehouses are so designed that storage facilities are provided for miscellaneous cargo, canned salmon and fresh fish, and apples and other fruits in cold storage.

Fig. 5 and Fig. 6 illustrate the plan of what is known

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as the Smith Cove pier, which has the distinction of being the largest pier in the United States, with the exception of the municipal dock No. 1, now in course of construction at Los Angeles. The Smith Cove pier is designed as a lumber and heavy commodity dock. On the outer end of the pier there are two sheds 600

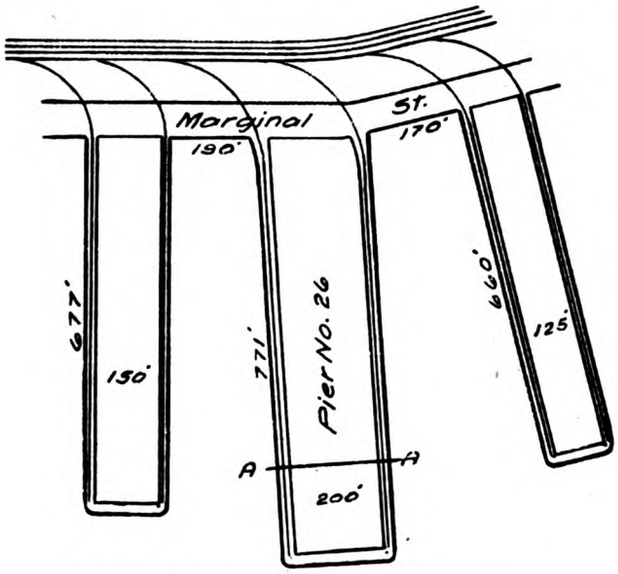

FIG. 11. PART OF SAN FRANCISCO WATERFRONT.

ft. in length for general cargo purposes. The remainder of the wharf is uncovered and will be equipped with a gantry and locomotive cranes, a 100-ton shear leg and other facilities for handling structural material, machinery, etc. Some conception of the size of the pier may be realized from the fact that there are over three miles of railway tracks upon it. The wharf construction is of the same type as the wharves being erected by the Port Commission, in that it is supported on creosoted piling. The slopes of the excavation are held at about 2 on 1 by the use of rock rip-rap protection.

The Bell Street dock, situated in the Central waterfront district, is designed to accommodate local and

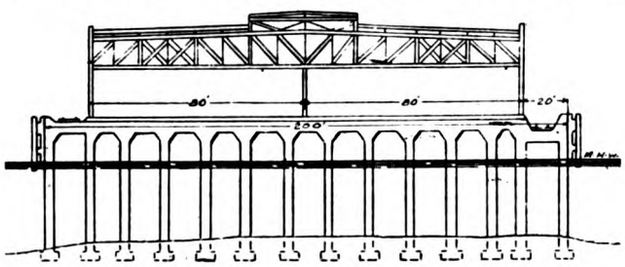

FIG. 12. CONCRETE PIER AT SAN FRANCISCO.

coastwise shipping. See Fig. 21. This dock is of a special design, in fact, rather unique on account of the special purposes for which it is intended as well as the local topography. The wharf is built around the waterfront sides of a 5-story concrete warehouse constructed on filled ground. At the north end of the structure is a basin in which are placed floats for the accommodation of motor and other small boats. The shed is two stories in height; the upper story being connected with an overhead viaduct which spans the railway tracks and meets the grade of the up-town streets otherwise separated from the waterfront by a 50-ft. bluff. By this means commodities destined for the nearby city markets and retail stores may be delivered by trucks direct from the second floor. The dock is equipped with three Barlow Marine elevators, which are so arranged that the elevator platform may be dropped to the level of the decks of the side port steamers, whatever the stage of tide. Goods are trucked thereby to the first or second floors with equal facility.

The improvements erected by the Port Commission supplement a number of good docks that have been provided by private enterprise. Most of the private docks, however, are best fitted to take care of local and coastwise shipments, the real need of the port being facilities for deep-sea shipping which the Port Commission has provided.

Port of San Francisco

The west side of San Francisco bay or that portion in front of the city of San Francisco is owned by the

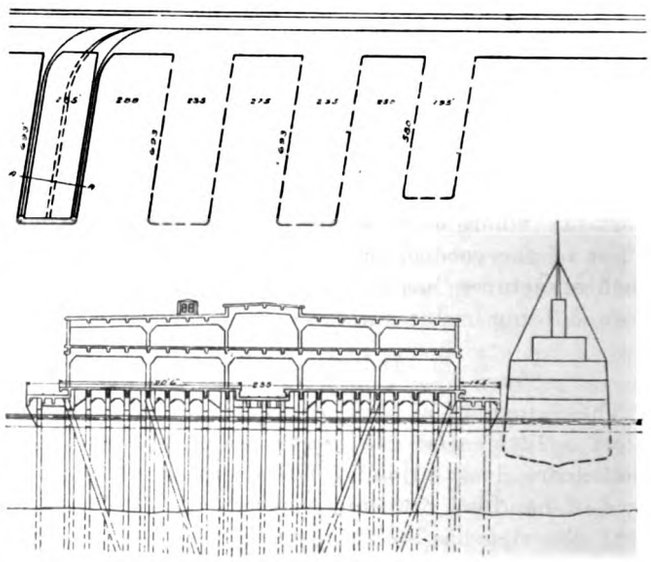

FIG. 13 AND 14. PLAN AND CROSS-SECTION OF DOCKS AT HALIFAX.

state of California and is administered by a Board of Harbor Commissioners appointed by the Governor. The public body, therefore, has a monopoly of the waterfront which simplifies its administration. In the past few years a large number of new modern piers have been constructed and several others are now under construction or about to be contracted for. The work during the last few years and that under way practically constitutes a rehabilitation of the waterfront. A number of the piers are constructed of reinforced concrete. See Fig. 11 and Fig. 12. Some of them are supported on concrete cylinders, others on concrete piles. Recently, however, it was decided to erect a number of the new piers on creosoted piling. See Fig. 3. The reason given for this is that the first

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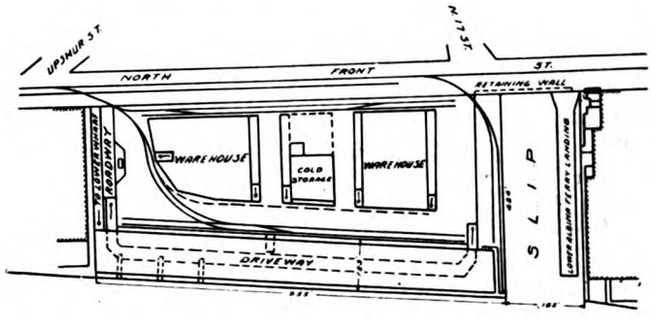
cost is considerably less than one-half that for the concrete structures and that there is an advantage in that, at the end of 20 to 25 years, new structures may be erected to take their place designed to meet the shipping conditions that will then prevail.



MUNICIPAL DOCK No. 1, PORTLAND, OREGON.

All the new piers carry railway tracks connecting with the public belt line. In most cases there is a track on each apron outside of the shed. On one side the track is depressed, bringing the car floor level with the deck of the wharf. Several of the new sheds have been so constructed that dock cranes may be installed if desired by the tenants. The spectacular feature of the waterfront is the great union ferry terminal at the foot of Market street. See Fig. 10. This is undoubtedly the largest ferry terminal in the world and has recently been enlarged to take care of the Exposition traffic. On the south side of the southerly slip a wharf has been erected, designed to accommodate motor boats and other harbor craft.

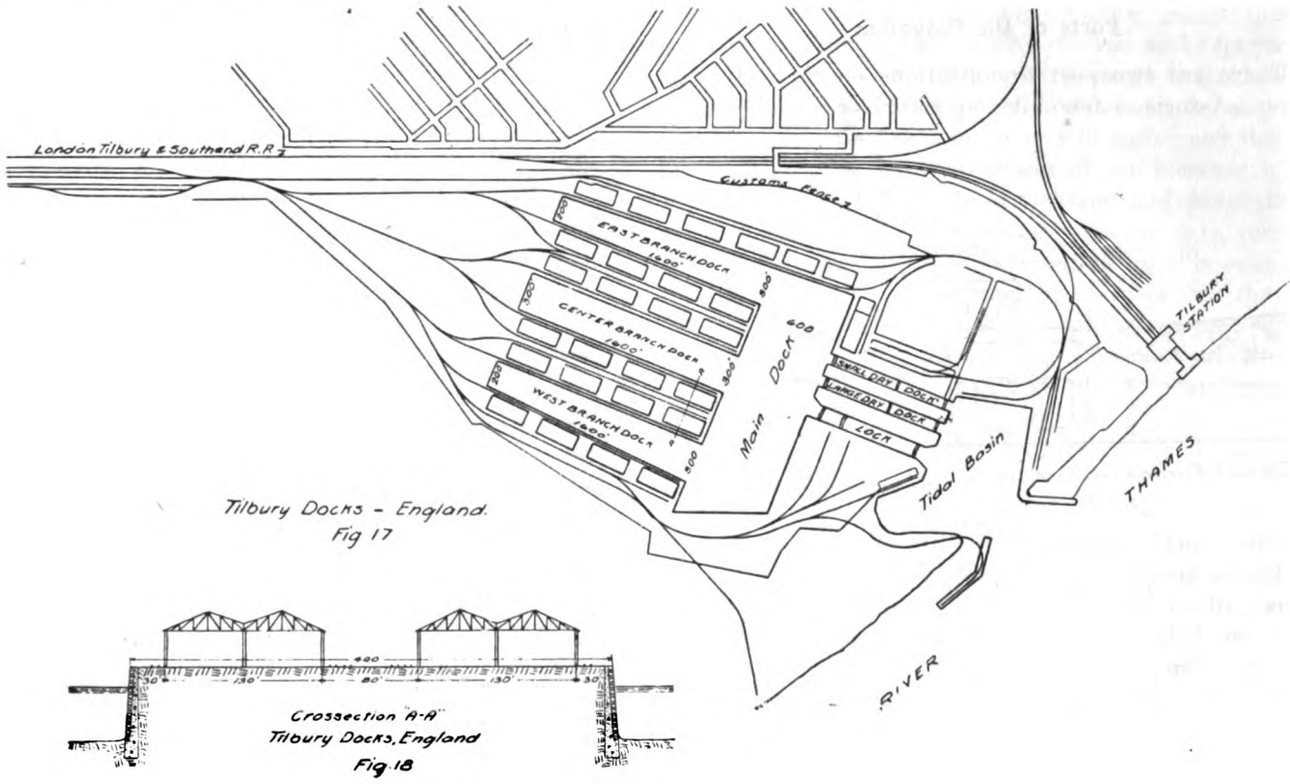
San Francisco has built up a splendid system of piers which would be a credit to any port. The only thing noticeably lacking is the failure to provide a warehouse system co-ordinated with the dock. Possibly local conditions are such as not to warrant the construction of warehouses by the Harbor Board.

Port of Los Angeles

When the state of California turned over to the city of Los Angeles the tide lands in and about San Pedro bay, Los Angeles pledged herself to spend at east ten million dollars in the construction of wharf and warehouse facilities. This, she has set about to do, having authorized five million dollars to start the work.

By far the largest and most striking improvement is what is known as municipal dock No. 1 on the outer harbor. It is in the form of a huge pier, the centre portion of which is filled with material dredged from the channels. On the East channel front a steel frame shed 1800 ft. long is about completed. A similar shed on the Main channel may be constructed. The space between the sheds it is proposed to use for driveways, railway tracks, and storage warehouses. The first unit of the warehouse system is to be erected during the year. Ultimately it is proposed to construct two 1400-ft. piers, with a slip between them, projecting from the outer end of the filled portion.

The wharf apron is constructed of reinforced concrete over a rock rip-rap slope. See Fig. 4. The shed, which is of steel construction, is built up close to the wharf in accordance with the New York practice, also the New York dock mast has been adopted; for a portion of its length a railway track is provided inside of the shed next to the waterfront side. In the rear of the shed depressed tracks are provided. When finally completed, this will be the largest pier in the United States.



Tilbury Docks - England.
Fig 17

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On one of the channels of the inner harbor a 1000-ft. shed has been erected on a creosoted pile key wharf. This is being used by the American-Hawaiian Steamship Company.

Port of San Diego

Upon the granting to the city of San Diego of the tide lands in front thereof, the city agreed to spend at

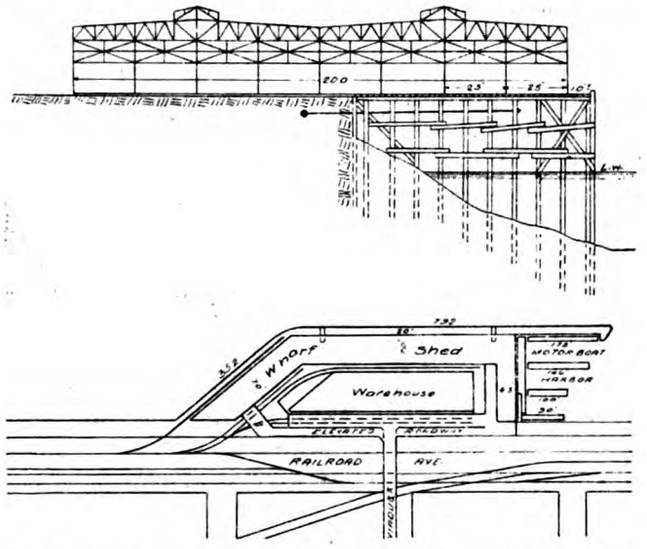
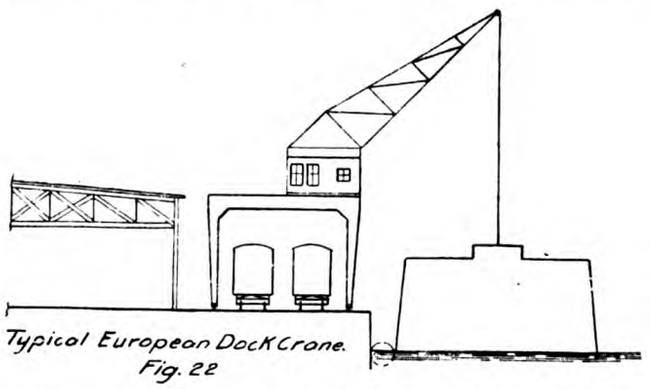


FIG. 19 AND 20. WHARF AT NEW ORLEANS AND STEAMER TERMINAL AT SEATTLE.

least one million dollars on an initial improvement. This has been done by the construction of one-half mile of concrete bulkhead and wharf apron and one splendid concrete pier 130 ft. in width and 800 ft. in length. There will be two railway tracks on each side of the shed, which will be 72 ft. in width and 765 ft. in length.

Ports of the Columbia

There are two port organizations on the Columbia river—Astoria, a few miles up the river, and Portland



at the junction of the Willamette and the Columbia. What is known as the Dock Commission of Portland was authorized to spend in the neighborhood of two and one-half million dollars. This was done by the construction of dock No. 1 on the west side of the river and dock No. 2 on the east side. The wharf portion of dock No. 1 was completed last summer. See Fig. 15. The plan calls for a very compact terminal. The space back of the wharf proper is being filled in with warehouses and cold storage buildings. The shed is a two-story structure of slow-burning construction, protected with an automatic sprinkling system. Untreated piling can be used on the Columbia river on account of its freedom from teredo. In connection with the construction of docks at a river port, it may be interesting

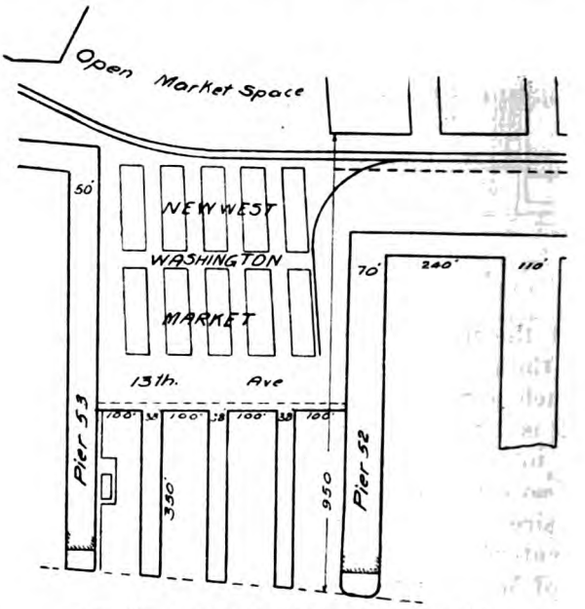


FIG. 21. LOCAL LANDINGS AT NEW YORK.

to refer to Fig. 19, showing typical cross-section of wharves provided by the port of New Orleans on the Mississippi.

Port of Astoria

This port is constructing a slip with a wharf on each side at a cost of approximately a million dollars. This improvement, which is of the slow-burning type of con-

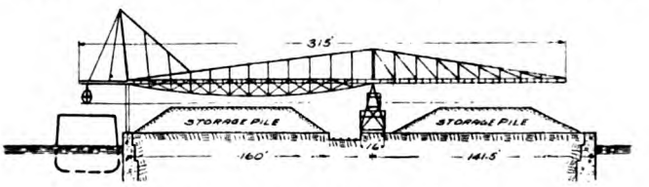


FIG. 23. LOADING CRANE AT WEST SUPERIOR.

struction, is designed to take care of a trans-shipping business, the saving of time between taking on cargo at Astoria or going up the river 100 miles to Portland being estimated to be at least two days.

It would be impossible within the limits of this article to go into a full description of all of the wharf and dock improvements, recently erected or now under construction on the Pacific coast, but enough has been said to indicate that the Pacific ports are getting themselves well equipped to handle the growing traffic. As a matter of fact as a result of keen competition in an effort to outdo each other, possibly each port has built ahead of its present needs, but if all predictions are well founded, it will be only a few years before com-

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merce will develop to the capacity of the facilities provided.

Conclusion

The Pacific Coast cities evidently are awake and alive to the importance of, at this time, laying broadly their fundamental plans for "Port Terminal Development." They are not overlooking the importance of first establishing the marginal street and belt line railway system, the backbone of the port terminal. The deep-sea terminals, that is, the arms of the port reaching out for over-seas trade, are being located with intelligent forethought. The local shipping wharves, that is, the legs carrying the burden of local traffic, are not being allowed to develop hit or miss fashion, but are treated as an important part of the comprehensive scheme. In conclusion, it is safe to predict that such a course, consistently adhered to, supplemented with progressive attention to details of construction and equipment, will make the Pacific Coast ports models of terminal efficiency and materially increase the prosperity of the entire region.

The Southern Pacific Transbay Suburban Passenger Rates*

By A. H. BABCOCK†

Your committee in asking me to address you today suggested as a subject that I should discuss the possibilities of electric traction in this neighborhood, particularly with reference to interurban service; in other words, to 'boost' the electrical interurban railway before you gentlemen.

In the face of the facts as shown by the present financial condition of many of the interurban electric railways in this locality, and the fact that the transbay lines are operating at a loss, I saw no way possible in which I could be much of a booster. Neither do I wish to appear continually before engineering audiences as a professional pessimist with respect to these very important developments. Your committee then asked me if it was a fact that the transbay lines are operating at a loss, and on being shown some of the monthly financial statements of these lines, it was then suggested that I should discuss this feature of the case and endeavor to remove some of the misunderstandings as between the public and the railroad officials with respect to these points.

The opening sentence of an address recently given by the President of the Southern Pacific Company before the Traffic Club of Chicago reads as follows: "The public interest in transportation is as keen as it is misinformed." Personally, I own to some confusion of mind when I hear sensible, intelligent men, who in their own businesses think deeply and clearly with reference to the things they handle, express openly and frankly a belief that the executive officials of a very large and responsible transcontinental railway either would or could so falsify public accounts as to show a loss where really a profit is being earned. And my mental confusion becomes almost amazement when such statements are made with reference to accounts that by law are under the direction and supervision of both federal and state governing boards. "Be thou as chaste as ice and as pure as snow, thou shalt not escape calumny," might apply here. It is a matter of common knowledge that the traveling public, especially commuters, indulges in much gossip regarding the alleged profits of large enterprises. Particularly is this so when such passengers gather daily on the ferryboats. The wildest rumors are stated as positive facts: for example, I have heard, as many others present doubtless have heard, that the profits of the transbay suburban lines pay all the operating expenses of the whole Central Pacific main line. We shall see about this later.

Another fertile source of public discontent may be traced back to the real estate office. In his argument of the recent case involving transbay rates, counsel for the Railroad Company made use of the following words:

"It is a very significant fact in this case, that these communities across the bay complaining before this Commission, being represented by counsel and experts, have not produced one man,—not a single individual have they brought before this Commission to show why those communities over there will suffer any detriment or any damage by reason of an increase of these rates. Are the people of Oakland and Alameda and Berkeley asleep? We assume that they are very much awake when they are represented by able counsel;—and they come here with all the notices that they have had and rest their case by producing two or three real estate agents and the President of this Protective League, who sits there on the stand and gives as his only reason why the rates should not be raised, that it would put an end to the development of that territory.

"* * * But those people over there have not come before you and said that if these rates are raised that they are going to suffer, that they are going to abandon their homes, that the property is not going to remain at its present value. All you have are some interested real estate men who come here—that is the protestants' case in a nutshell—and say that they do not want the rates raised because it will interfere with the sale of the lots."

*Address delivered before Electrical Development League, March 31, 1915.

†Consulting Electrical Engineer, Southern Pacific Company, San Francisco.

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It is with these thoughts in mind that I propose to review very briefly the recent cases heard by the Railroad Commission of the State of California, in order that you gentlemen shall appreciate the significance of the investigation as to valuation and operating expenses, and the results as submitted under oath by the most responsible officials of the Southern Pacific Company.

As indicating the different points of view at the time of this hearing, two complaints had been made for a reduction of rates. These complaints originated with the land improvement companies. At the same time there were three applications before the Commission made by the Railroad Company for increases in rates. The basis of the application for reduction in rates, made by the improvement companies, was that several of the lines were paying well, and consequently their profits should not be used to pay the operating expenses of lines that were not paying well. These applications had been made on both the Seventh-street line and the Melrose extension of that line. It is a striking fact that the decision in this case, adverse to the Railroad Company's request for an increase of rates, was based by the Commission on the ground that the Oakland, Alameda, and Berkeley electric lines, being a part of and really feeders to a transcontinental system, might show a loss in operating account as far as these lines were concerned specifically, but as feeders to the main lines they were really serving a valuable purpose; consequently their losses should be made up by the main line profits; while counsel for the improvement clubs and real estate men used these words:—"I shall insist that the Seventh-street line is a paying line, and the burden of carrying the Ellsworth line, carrying all of these dead lines, some of the Alameda lines too, should not be thrown upon the people resident upon the Seventh-street line; that it is a segregated entity, and that there has been waste and extravagance and so on, but that that is a matter that should not be thrown upon the rate payers on the Seventh-street line to help it out; that the Southern Pacific Company will have to look elsewhere for its remedy."

In other words, the decision was that the transcontinental system, which is paying dividends in general, should carry the losses of the electric system, while the improvement companies were asking that the earnings of the paying lines should be reduced because they were being made to carry the non-paying electric lines.

The general argument followed by the railroad counsel in presenting his case was to show, first, the values of the property devoted exclusively to interurban business; second, to show the manner in which the lines are operated, and how they are handled, generally speaking. The next step was to show how the revenue statements were prepared, and also the statement relative to the operating expenses of the property, together with detail testimony of the manner in which checks are made to determine the volume and density of the traffic. The case was closed by the passenger officials, who argued the reasonableness of the rates upon the comparative method.

Taking the valuation of the lines in Oakland, only that part of Oakland pier which was segregated for the use of the electric lines was included, and also that part of the boat-yards and the floating equipment that is devoted to the electric-line service. In making up these figures the rules of the Interstate Commerce Commission as to itemized statements were followed; and the value of the property used for electric service was very carefully segregated from the main-line service. This could be done easily along the Sixteenth-street extension to Shellmound, but on the Oakland pier the matter was a little more difficult; and finally, for the reason that the steam track mileage and the electric track mileage on Oakland pier are substantially equal, the costs were divided equally, and one-half of the total was laid against the electric service; that is to say, the Oakland pier sub-structure cost was divided equally, and to that was added the cost of the tracks and overhead structure devoted exclusively to electric service. As indicating some of the costs of such improvement, it may be stated that the valuation of Oakland pier sub-structure as taken in these accounts was $1,768,876.

The segregation of the ferry service values, namely, the steamers *Berkeley, Piedmont,* and *Newark,* these being the boats run between San Francisco and Oakland pier, was on the basis of the number of passengers carried, namely 13.4% of the total number of passengers were delivered to the steam trains, and 86.6% were delivered to the electric trains, and the values of this floating equipment were segregated in those proportions. To this was added the cost of all the boats running to Alameda pier, because these do exclusively electric service business. The value of the shipyards at which these vessels are repaired was determined on the same basis, as was also the total cost of repairs made on the boats.

The following figures are interesting as showing the cost of the electrical improvement. The figures given are the totals exclusive of the values of the rights-of-way, the rolling stock and the real estate: For the Seventh-street line, $2,571,967; for the Fourteenth-street local and the High-street local, $1,047,880; the Berkeley local, $694,531. The total amount expended, therefore, on additions and betterments of these lines amounted to $4,314,378. These figures include the division of the sub-stations and power-plant, but no rolling stock. For this latter the expenditure up to June 30, 1913, was $1,915,267. The foregoing figures all concern steam lines electrified. Now for the extensions:

The Melrose and San Leandro extension, including real estate, but not including rolling stock, was $315,796; the cross-town lines in Alameda, $182,509, not including real estate; for the Peninsular railway, in-

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cluding real estate, $1,285,764; for the California-street line in Berkeley, including real estate, $444,648; for the Ellsworth-street line, including real estate, $298,115; for the Ninth-street line, including real estate, $491,461; for the Berkeley local extension of Vine street to Colusa avenue, $723,646. The total cost of extensions, improvements, and rights-of-way, etc., was $3,741,938.

In the foregoing manner the entire reproduction value of the property devoted exclusively to electric business was determined to be $26,553,667.45. It should be noted that these figures cover that part of the property used exclusively for electric service, excepting a segregation on Oakland pier and of the lines as far as Shellmound junction, between the steam and the electric service, the said segregation being made upon the actual uses of the property by the two services. It should be noted further that the figures do not include any terminal buildings, or terminal ground in any of the cities; and finally, that the valuation of the floating equipment and its repair facilities, and also, the operating expenses thereof, are divided strictly between the steam and electric service on the basis of the passengers carried by each. Moreover, in arriving at these figures full credit was given the electrification for all old obsolete material released and removed.

After checking over the valuations submitted by the Company, Richard Sachse, Chief Engineer for the Commission, reported that while his department differed in some respects from the valuations as furnished by the Company, taking the matter as a whole, in his opinion, the valuations submitted were not too large. Mr. Sachse afterward modified this to the expression, "with the possible exception of the land value, otherwise the statement is absolutely correct."

The statement of the revenue earned by the different lines was determined by an actual check of passengers as counted by the fare registers going one way and by a force of men employed for this purpose covering the period of the determination. The first step was to separate the traffic into the through traffic, that is to say, the traffic between the east side and San Francisco over the suburban line, and the local traffic in those suburban zones. This was done by counting the passengers in the cars at the time they left Oakland pier, eastbound, and then counting the passengers actually boarding the cars at local stations. The check of the passengers leaving the pier is made on every train that leaves that terminal and is reported by the train crews as a part of their regular duties. The trainmen working in connection with the special checkers employed for that purpose, counted the additional passengers on at the local stations.

On the westbound trip, that is toward San Francisco, there were available the regular counts made of passengers on the trains entering Oakland pier, and the fare registers showed for the same trip the total number of passengers carried on the cars; that is to say, the fare registers gave the total of the local and through passengers, and the counts as made running up the pier gave the through passengers. The difference between the two, then, would be the local passengers. These figures, however, did not give the points at which the passengers originated, and the check of this item had to be made in the same way as for the eastbound passengers, namely, by special count made by the trainmen and extra checkers. In this way the density of traffic at all points was determined with a high degree of accuracy. In addition to the foregoing, a segregation had to be made between revenue and non-revenue passengers; this was easily accomplished by counting the tickets. Also, the segregation between the passengers boarding the train on the east side of the bay to come to San Francisco as separate from those going to the main-line trains, was easily made because the main-line passengers have a special coupon that they present for fare.

In determining the revenues and expenses of these lines, the Interstate Commerce Classification of Accounts was followed as in the construction and the cost account. This classification specifies in great detail the items to be charged to the various accounts. Most of the items are self-explanatory, but such an account as 'Miscellaneous Revenues and Expenses' includes the revenue from mail service, that is, payment by the Government for transporting the mails; the news-stands, based on the number of cars passing over the different lines for those news-stands along the track, but based on the actual passengers passing the station in the case of the news-stands at the pier; and for the train agents, based on the passengers carried on the lines to which these train agents sell, also similarly for telephone booths and bootblack stands. The express business is handled on a slightly different basis. The receipts from express matter allocated to the California lines, are divided between the electric and steam service in the proportion of relative road mileage of the two services, it being impossible to determine the actual express revenue over the electric lines. The payments on account of franchise rights are easily segregated to the different lines to which they refer. In the case of franchise payments to the city of Oakland for rights on that part of Oakland pier belonging to the city, these payments are divided in the proportion of one-half each to the steam and electric lines, on account of the fact that the track mileage on the pier is divided approximately equally between the two services.

With reference to the items of depreciation: It is considered that power-plants, power-station plant and equipment are being depreciated at the average rate of 4.6% per annum; rolling stock at 3.87% per annum. The expenses involved in replacements of track material and overhead parts can easily be charged directly against the line to which they refer; but in the case of joint function, such as the interlocking towers between the Southern Pacific, the Santa Fe,

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and the Key Route tracks, a little different procedure is necessary. In these cases a man was sent into the different towers to make an actual check of the number of movements performed in handling trains of all classes, from which was derived the proportion of cost of operation of these plants to be charged against the electric service. For instance, they were charged with just that proportion of the total operating expense their train movements caused the tower to make.

The maintenance of equipment is charged against the 'General' account and segregated to the different lines in proportion to the car mileage. This is done in the same manner with respect to the station-agent charges. Wherever there is only electric service, of course, the charge can be laid directly against the line, but in other cases where there is a sale of both steam and electric tickets, the electric service is charged with its actual proportion of tickets sold over the electric line, to the total service of the office.

The general office expense is charged on an arbitrary basis. Usually about $50 to $100 per month is charged for those officers directly concerned in the handling of the particular property. It amounts, roughly, to between $600 and $700 per month.

The earnings of the restaurants and bars on the Oakland route are based on the proportion of passengers carried, and on the Alameda service all the receipts are credited to the suburban lines.

Distribution of charges made for repairs to wharves is on the same basis as for the restaurants and bars, but the cost of handling baggage is determined by the actual number of pieces handled.

The recapitulation of all the figures for the four months for which the statement was made, shows a deficit chargeable to the electric lines of $115,984.07, and these figures do not include interest on the investment: this included, the deficit amounts to $686,515.41 for the electric lines alone. Adding the ferry deficit in a similar manner, the figures become $752,754.24, or an average annual deficit of $2,258,262.72, which amounts to 11.81c. per passenger carried. It is interesting to compare, here, the revenue per passenger necessary to remove the above deficit, viz.: for the electric lines alone, 15.45c.; for the ferry lines, 4.62c.; and for all lines, 20.07c. The gross operating revenues are 8.26c., which leaves the deficit 11.81c. as above.

Mr. Shoup's testimony in justification of higher fares than at present are obtainable was substantially as follows: The transbay service cannot be compared with street-car systems because the operations over these require more expensive equipments; they operate at higher rates of speed, and they have to pay, as a rule, higher wages; furthermore, more men per car are used than in street-car service. The cost of the rolling-stock, on the average, is about double that on street-cars. The street-car men on the smaller cars receive 30c. per hour, so also do the gatemen on the trains, but the trainmen on the trains, other than the gatemen, receive as high as $5 per day. These rates are governed by the steam-railroad schedules that were in operation before the electrification.

With reference to the 5c. fares charged on these trains: owing to the weight of the equipment, etc., they operate at a disadvantage. Ordinarily the 5c. fare is a kind of 'blanket' charge to cover all movement throughout a city, and as such in general is all right, because passengers, as a rule, ride only short distances; but Arnold's investigation in Los Angeles showed that there was an operating loss when a passenger was carried more than five miles from the centre of the city. The effect of the short haul on this business may be shown by the fact that a check made recently on one of the other systems of the Southern Pacific company showed that before the jitney came, approximately 2c. per passenger-mile was received throughout the congested district. The increased fares requested at the time of this hearing would mean that for the long haul from West Oakland to Seventh avenue, for example, if the increases were granted the receipts would average about ½c. per passenger per mile for all passengers carried through to West Oakland; but from the centre of Oakland to Seventh avenue, they would average a little more, approximately ⅝c. per passenger per mile. A municipal boundary is utterly impracticable as a regulator of passenger rates of this type. For example: the city line of Oakland now coincides with the San Leandro line. To maintain a 5c. fare over this distance puts the street-car service on a par with the interurban lines, where it has been found by long experience that fares all the way from 2 to 3c. per passenger-mile are requisite for anything like coming out even. On the other hand, the electrification was necessary on account of the complaints that were being made against the steam service, and because of the fact that franchises for steam operation were coming to a close, and it was very doubtful that any of these could be renewed except on the electric basis. It has been contended that possibly an electrification on a less comprehensive scale might have done better. The answer to that, is, that the electrification once made must be for a very considerable period of time ahead; in other words, the locations of the new lines must be such that will reach a very large section of territory without asking a passenger to walk more than four or five blocks in any one direction to reach his train. This explains what looks sometimes like a duplication of service.

Under examination by the Commissioners at the close of his cross-examination, Mr. Shoup testified that in his opinion the financial situation of those lines on the other side of the bay is such that he would recommend turning over the entire system to any railroad company at cost. He went on further and stated he did not consider that the advantage obtained by the Southern Pacific company using these lines as feeders to the main line compensated at all for the present average annual deficit.

The cases were submitted September 2, after argument, and on October 10 a report was made with an order denying the railroad's applications for rate in-

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creases and dismissing the complainants' request for rate decreases.

Some of the significant passages of the decision are abstracted below:

"A careful and *bona fide* effort on the part of the company has been made to show the real conditions surrounding the service here performed, and much testimony and many intricate tabulations, accompanied by statistical data, have been presented. * * *

"The company places a valuation of its suburban electric system and a part of the joint facilities which on its basis of apportionment are properly chargeable to the suburban service, including ferryboats, at the sum of $26,553,667.48. * * *

"The engineering department of the commission reports that on the basis of apportionment adopted by the company its valuation is reasonable and that it could not be reduced to any appreciable extent. * * *

"Very little controversy exists as to many of the facts, but wide divergence of opinion is found with reference to the significance of such facts. In a proceeding such as this, wherein rates are to be raised, the burden must be assumed by the company to prove its contention, and while it is not for this commission, under any circumstances, to resort to technicalities in order to bring about any particular result, yet, under the peculiar circumstances of this case, more than any other case presented to this commission, the strictest adherence to proof on the part of the company seeking to raise these rates must be insisted upon. In the case here involved we feel no hesitancy in saying that the strictest presumptions of law should be adhered to against this company, not for the purpose of confiscating its property, but for the purpose of preventing the confiscation of tremendous values in the property of the residents of Alameda county. * * *

"An increase of the commutation rate alone will confiscate or take away from (the term used is immaterial) the value of the residences of every person in the territory here involved who is forced by business reasons to commute to San Francisco. Confiscation in this case looks both ways, and it does not lie in the mouth of this carrier to urge its own confiscation in utter disregard of the confiscation which it, if permitted to have its way, will have brought about among innocent people who are its patrons. * * *

"We are of the opinion that the company has been very considerate of the people of the east bay territory in the extension of its lines and the extension of its $3 commutation and 10-cent single-fare rates. Such fares, when not voluntarily accorded, of course, must end somewhere. We are of the opinion that as to the portions of these east bay cities and Alameda county other than those points to which the $3 commutation rate and the 10c. single-fare rate have been heretofore voluntarily accorded or established, the company should not be required to accord them. * * *

"It may appear that we do not appreciate the diligent effort of the company to present all of the facts surrounding this case. We do appreciate this, and we also appreciate the fact that this company is giving a tremendously valuable and efficient service to these Alameda-county points, and while, as we have said herein, the company should be held more strictly to account in according these rates in the future which it has voluntarily accorded so long in the past and on the faith of the continuance of which so many people have acted, yet we do not believe that this should be made the basis for forcing this company, by reason of alleged discriminations, further to extend these commutation rates to territory not presently profitable, nor that these rates should be taken as a basis for comparison in other territory not similarly affected. The facts in any other case presented to this commission must determine such case; and it might be that conditions exist that justify for similar distances even a lower rate, or they might justify a much higher rate. The mere fact that these rates are accorded for a prescribed distance in Alameda county means no more as a basis for comparison than the comparative rates presented by the company in this case for similar distances in other localities under dissimilar conditions. * * *

"We suggest to the people of Alameda county, particularly those engaged in the opening up of new tracts for settlement, that they in the future should not proceed on the assumption that this commission will require this company further to extend its $3 monthly commutation rate."

If ever a case was presented completely, thoroughly, this one was. If ever a case justified increased rates, this was that case. The facts alleged by the applicant, both as to valuation and as to operating expense, were not controverted. They were established beyond question because the facts were there, complete and in such shape that no one could mistake them. Yet, the commission handed down this order:

"It is hereby ordered that the applications hereinabove referred to be and the same are hereby denied. It is further ordered that complaints hereinabove referred to be and the same are hereby dismissed," a decision that cut the knot by denying the right of both parties to the relief they claimed; but observe that the application of the railway concerned every district of the transbay cities served by its ferry and suburban service, while the complaint for reduction of the Melrose rates affected merely a precinct or two. The difference is important.

For the time being, then, the people of Alameda county are enjoying what the commission calls "a tremendously valuable and efficient service" at much below cost. If recent court decisions be any guide, the logic of the commission's reasoning is at least questionable. Yet we bow to the will of the sovereign State of California as expressed through its railroad commission, cherishing the belief that the transbay rates will not be used to determine other rates under other conditions. Nevertheless the result of our experiment will be closely studied and watched by investors in similar public utilities, and I leave it to you gentlemen to determine how depressing an effect it is likely to have upon electric railway development.

In my introductory remarks, I referred to President Sproule's opening sentence in a recent address; now I will close with another quotation, almost the last words of the same address: "When misapprehension is prevalent and misunderstandings are rife, it is the duty of every man connected with responsible business to do his part to clear them out of the way and create a better atmosphere that we may have better conditions."

This, gentlemen, is my excuse for appearing here before you today, and for venturing to discuss matters outside of the technical field.

As a substitute for clay in rebabbiting bearing-boxes, the following has been found useful: Reduce putty with cylinder oil until it is almost as thin as the oil itself; next take some powdered asbestos and add it to the putty mixture until it is a stiff compound as dense as the putty was at first.—*Mechanical World.*

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Cost of Construction of Rock-Walls and Culverts on Columbia Highway

The construction of the Columbia Highway, in Multnomah county, Oregon, called for the building of a number of dry rock-walls and culverts. The following table of cost data is taken from the first annual report of state highway engineer Henry L. Bowlby. The work was done by day labor during the season of 1914, under the direction of John B. Yeon, roadmaster of Multnomah county.

Dry Rock Culverts—

Station	Size	Length	Surface yards rock wall	Concrete top slab cu. yards	Foundation	Quarrying and Hauling	Construction	Total cost of walls	Cost of concrete slab	Walls and top complete
259+03	6x8	40	183.0	30.0	$ 112.31	$ 461.68	$ 939.64	$	$	$ 1,513.63
270+0	6x8	24	96.0	13.0	62.39	195.97	425.59			683.95
288+0			18.0				33.52			33.52
355+0	4x4	36	59.0	9.0	75.03	84.48	228.12			387.63
Total, Camp 4			356.0	52.0	$ 249.73	$ 742.13	$ 1,626.87			$ 2,618.73
154+62	4x10	28	53.0					$ 300.09	$ 419.45	
156+60	4x4	24	48.0	30.0				89.83	114.89	
142+45	4x4	35	56.0					280.52	138.41	
225+62*	4x4	36	57.0					222.33		
386+70	4x4	26	56.0	7.0	14.00	46.75	85.37	146.12		
234+83	4x4	60	96.0	24.0				333.85		
240+73	4x4	54	88.0	13.0				234.45		
250+82	4x4	28	53.0	7.0				292.09	897.98	
256+78	6x10	50	82.0	28.0				590.43		
268+0	4x4	40	53.0	10.0				326.66		
280+0	4x4	24	48.0	6.0	94.75	142.90	112.15	349.80		
Total, Camp 1			690.0	125.0				$ 3,166.17	$1,570.73	$ 4,736.90
383+57	6x10	24	109.4	9.6	$ 120.00	$ 57.50	$ 230.75	$ 408.25		
399+65	4x6	24	65.8	4.8	125.00	55.25	113.22	293.47		
432+80	6x10	24	122.0	9.6	101.87	94.97	329.40	526.24		
438+90	4x6	24	71.1	4.8	63.50	32.25	280.65	376.40		
444+10	6x8	24	98.5	7.3	184.53	63.25	298.15	545.93		
448+50	6x10	24	109.4	9.6	45.00	24.25	277.25	346.50	945.31	
455+33	8x12	24	142.8	12.3	128.50	55.87	338.75	523.12		
461+64	6x8	24	98.5	7.3	58.50	27.50	194.80	280.80		
474+90	6x8	24	98.5	7.3	123.75	108.00	181.75	413.50		
486+88	4x8	24	67.3	7.3	54.00	70.25	158.50	282.75		
497+11	4x5	24	54.7	4.2	22.50	75.75	125.75	224.00		
Total, Camp 5			1038.0	84.1	$ 1,027.15	$ 664.84	$ 2,528.97	$ 4,220.96	$ 945.31	$ 5,166.27

Dry Rock Walls—

Station	Surface yardage for heights of 0-6 ft.	6-12 ft.	12-18 ft.	18-24 ft.	24-30 ft.	Total surface yardage	Length of rock haul	COST Found'tions	Quarrying and hauling	Construction	Overhead charges	Total cost	Cost per surface yard
26+45	11.4	26.1	46.0	24.8		108.3	700	$ 118.49	$ 316.20	$ 173.25	$ 34.73	$ 642.67	$ 5.93
37+51	24.4	42.0	48.7	16.2		131.3	400	74.50	51.40	528.60	42.02	696.52	5.31
40+60	67.9	98.1	107.3	48.9		322.2	800	192.65	74.65	2,084.65	103.33	2,455.28	7.62
46+0	18.8	16.9				35.7	600	27.00	30.55	186.90	11.45	255.90	7.17
47+0	11.0	31.5	42.6			85.1	700	38.95	80.40	225.60	27.29	372.24	4.37
49+35	24.0	18.8				42.8	900	11.50	59.30	252.60	13.73	337.12	7.88
72+57	74.9	95.1	39.6			209.6	2200	155.75	170.70	602.35	67.21	996.01	4.75
76+35	44.1	74.7	39.8			158.6	1800	215.00	159.25	461.55	50.86	886.66	5.59
86+80	9.0	27.0	20.5			56.5	700	81.50	36.90	148.25	18.12	284.77	5.04
89+30	28.8	43.3	21.7			93.8	500	33.40	46.80	354.95	30.08	465.23	4.85
92+85	23.1	56.0	61.1			140.2	300	76.75	79.00	379.75	45.09	580.59	4.14
Camp 3	337.4	529.5	427.3	89.9		1384.1		$ 1,025.49	$ 1,105.14	$ 5,398.45	$ 443.91	$ 7,972.99	$ 5.76
157+0	7.0	20.6	2.1			29.7	300	$ 8.99	$ 40.62	$ 40.51	$ 5.19	$ 95.31	$ 3.21
162+10	22.2	55.1	108.1	138.6	91.3	415.3	300	627.65	148.21	973.76	72.55	1,822.17	4.38
173+50	7.0	21.0	34.3	48.4	9.4	120.1	600	50.00	100.94	70.00	20.98	241.92	2.01
177+0	5.6	12.7				18.3	400	7.00	15.00	16.25	3.20	41.45	2.27
182+38	23.7	32.1				55.8	300	15.00	59.20	24.00	9.75	107.95	1.93
192+06	47.8					47.8	300	47.50	45.00	50.00	8.35	150.85	3.16
206+10	42.3	137.1	167.7	176.6	47.1	570.8	300				99.72		
210+25	26.2	65.8	118.6	137.7	54.7	403.0	300	452.30	1,260.86	1,433.07	70.43	3,316.38	3.41
Camp 2	181.8	344.4	430.8	501.3	202.5	1660.8		$ 1,208.44	$ 1,669.83	$ 2,607.59	$ 290.17	$ 5,776.03	$ 3.48
244+23	22.0	65.8	163.0	193.0	233.5	677.3	400	$ 409.02	$ 1,400.20	$ 2,145.63	$ 167.50	$ 4,122.35	$ 6.09
253	14.3	21.2				35.5			78.16	47.74	8.78	134.68	3.79
253+30	29.2	71.5	110.9	53.5		265.1	2200	223.10	823.70	498.13	65.56	1,610.49	6.09
258+26	8.0	26.0	54.7	96.8	113.8	299.3	1700	58.84	697.14	599.07	74.01	1,429.06	4.77
304+42	28.8	44.8	56.4	62.9		192.9	2900	202.65	565.50	414.04	47.70	1,229.89	6.37
305+60	73.5	243.4	132.7			449.6		672.24	471.04	1,019.36	111.19	2,273.83	5.06
310+75	18.3	47.0	67.2	79.3	107.3	319.1	600	190.31	570.92	1,031.92	78.97	1,872.12	5.87
Camp 4	194.1	519.7	584.9	485.5	454.6	2238.8		$ 1,756.16	$ 4,606.66	$ 5,755.89	$ 553.71	$12,672.43	$ 5.66
134+50						912	300				$ 108.34	$ 2,921.02	$ 3.20
142+88						361	500				42.89	962.62	2.67
145+50						131	500				15.56	267.10	2.04
147+0						260	400				30.89	679.20	2.61
149+80						363	500				43.12	493.15	1.36
153+0						139	500				16.51	522.60	3.76
159+50						1197	500				142.20	4,627.98	3.86
170+50						118	500				14.02	331.97	2.81
176+0						116	800				13.78	453.38	3.91
216+0						480	200				57.02	1,087.94	2.27
221+50*						292	200				34.69	264.92	0.91
250+50						551	800				65.46	1,544.61	2.80
191+0						777	1000	$ 130.80	$ 2,101.10	$ 1,711.45	$ 92.31	$ 4,035.66	$ 5.19
206+10						1860	400	181.00	2,352.45	2,980.30	220.97	5,734.72	3.08
259+75						1486	1000	475.77	1,920.92	2,517.27	176.53	5,090.49	3.43
274+0						220	400				26.13	579.88	2.63
277+75						43	400				5.11	193.11	4.49
Multnomah Creek Bridge						32	500				3.80	119.95	3.75
Oneonta Tunnel						30	200		58.20	87.25	3.56	149.01	4.97
Horsetail Creek						60	200	32.75	125.68	146.00	7.03	311.46	5.19
Camp 1						9428.0					$ 1,119.91	$30,370.76	$ 3.22

* Station 221+50 is rough toe wall 6 ft. high.

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The Accumulation of Petroleum Near the Outcrop of Oil Sands

By LEON J. PEPPERBERG*

The enormous oil production of California has resulted in extensive investigations to determine the geological conditions which govern the accumulation of petroleum in these fields, and owing to the wide publicity given to the bulletins of the United States Geological Survey describing them, together with numerous articles published in various technical journals, the general conditions under which oil is found in these fields are known throughout the world.

A condition common to the California fields is that asphaltic oil seals the oil-sand outcrop sufficiently to retain a large portion of the oil originally accumulated in the reservoir, and, as has been demonstrated, drilling down the dip from the exposed oil-sand in these fields often results in bringing in good production. The application of this California practice to untested districts where the rocks are known to contain large quantities of water, and where the oil produced in the region is known to be of paraffin base or to contain only a small percentage of asphaltum, has, in every instance observed by the writer, resulted in failure to develop commercial production.

Three factors recognized by all authorities as fundamental to the accumulation of petroleum are:

First—A source from which oil can be derived.

Second—A reservoir consisting of sandstone or other porous strata.

Third—An impervious capping which will prevent the escape of the oil from the reservoir.

When the above three factors have been determined by field observations, it is necessary to locate a geologic structure where oil is most likely to accumulate, before sinking a test well. This structure may be one or a combination of several structural features. A few of the most common in which oil in commercial quantities is found are the anticline, dome, monocline, terrace, enclosed lens of porous strata, and occasionally in faulted zones, dry synclines, and areas adjacent to intrusives. Just which structure is favorable in a given locality depends largely upon the past and present regional climatic conditions and to *just as large an extent upon the composition of the oil which is believed to be retained in the strata.*

Given a source from which oil can be derived, a reservoir, an impervious capping to prevent the escape of the oil, and proper structural conditions, we have an oilfield waiting to be made a part of one of the world's greatest industries by the simple drilling of wells. What happens to these large accumulations of oil when the reservoirs containing them are opened to the surface by erosion, faults, or the intrusion of igneous rocks? The only logical answer is that the oil will escape from the 'barrel which has had its head knocked in.' If in a given locality oil is being generated faster than it is leaking out of the vent formed by erosion, faults, etc., some oil may yet be won from the opened reservoir. If the strata are free from water in large amounts, only a portion of the oil will escape, and the remainder may yet be won by drilling down the dip from the outcropping sand and tapping the reservoir on the limb of the anticline, monocline, or even in the low structural points along the synclinal axis.

The above statements apply to all mineral oils, no matter what the character of the petroleum, but the chances of obtaining a profitable production from *a reservoir which has been opened by nature* is dependent largely upon the original amount of oil generated, and, in regions where the strata are saturated with water, *upon the composition of the oil.*

The fact that oil accumulates down the dip from the outcrop of oil-sands in California is so deeply rooted in the minds of certain geologists and many operators that the equally important fact that paraffin oils will not seal the sands sufficiently to retain the oil in commercial quantities is usually overlooked. This is borne out by numerous published articles. The writer appreciates that much valuable data are published by the U. S. Geological Survey, and that conclusions drawn by government geologists are bound to direct prospecting along certain lines. In order to bring out the case in hand forcibly, it is necessary to refer to Survey bulletins, and for this purpose certain localities in Wyoming have been selected. It is beyond the scope of this paper to describe the geology of the oilfields of Wyoming in detail. Good geologic maps and descriptions of these fields are given in the publications of the Survey.[1] In the Lander, Salt Creek, and Powder River oilfields of Wyoming the following oil horizons, given in descending order, are recognized: Shannon sandstone, Wall Creek sandstone, Dakota (?) sandstone, Morrison formation, Sundance formation, and the Chugwater-Embar zone.

Of these, the Shannon is a small producer in the north end of the Salt Creek field. The Wall Creek is the most prolific yet found in the Salt Creek field, and is the reservoir from which the major production of the state is obtained. No important production has yet been developed from the Dakota, although the outcrop of this formation often shows indications of oil and at several places a few barrels of oil have been

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[1]Wegemann, C. H., 'The Salt Creek Oil Field, Natrona County, Wyoming,' U. S. G. S., *Bull.* No. 452 (1911); Woodruff, E. G., 'The Lander Oil Field, Fremont County, Wyoming,' U. S. G. S., *Bull.* No. 452 (1911); Wegemann, C. H., 'The Powder River Oil Field, Wyoming,' U. S. G. S., *Bull.* No. 471-A (1912).

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won from it. The Dakota is the chief source of artesian water in South Dakota and Nebraska. The Morrison and Sundance formations contain oil seeps in the Powder River field, but as yet they are not of proved economic importance as a source of petroleum. The oil of the Lander field is obtained from the Chugwater-Embar zone.

The Powder River oilfield lies about 15 miles northwest of the Salt Creek field. The geology and structure of the two fields are very similar except that the Powder River dome has been eroded much deeper stratigraphically than the Salt Creek dome. As a result of this erosion, all of the oil horizons from the Dakota sandstone to and including the Sundance formation are exposed along the eroded axis of the dome. The Wall Creek sandstone forms an escarpment on the outer flanks of the dome, and the Shannon sandstone forms a second escarpment farther out from the structural axis. As has been demonstrated by development in the Salt Creek field, dome structure is favorable to the accumulation of petroleum in large quantities in this region where the strata are known to be highly saturated with water. The Powder River dome structure, then, is favorable, but Nature has cut through five of the known oil-containing formations in this structure and has allowed large portions of the fluid to escape. The question naturally arises in the minds of those who are conversant with California practice, 'Why not drill down the dip from the oil-sand outcrop?'

Field observations have convinced the writer that this sort of reasoning is folly, and not only adds a great risk to an already hazardous business but up to date has been the cause of the expenditure of hundreds of thousands of dollars which have been a total loss to the prospecting companies. Concerning the distribution and the possibility of finding oil in the Powder River field, and the character of this and other oils from Wyoming fields, the U. S. Geological Survey reports as follows:[2]

"Oil has been found in five different beds in the Powder River field. Of these the lowest is the Sundance,[3] * * * A massive sandstone about six or seven feet thick near the base of the Morrison formation contains a small quantity of oil,[4] * * * In the Mowry shale member, oil is reported in small quantity in the well in Oil Canyon, where a few quarts was obtained at a depth of about 300 feet. The principal reservoir in the field, however, is the coarse conglomerate sandstone, 56 feet thick, which is in this report doubtfully called Dakota. On account of its character and thickness, this is an excellent reservoir for the storage of oil. It has been prospected with results that have not been altogether encouraging. *A glance at the map, however, will show that while the west side of the dome has been prospected fairly well, no drilling has been done on the east side, which is, under any theory of oil accumulation, the more promising of the two.*

"The open wells in Trail canyon, situated on the crest of a secondary fold previously described, which here forms also the axis of the anticline, obtained oil from the Dakota sandstone,[5] but the well in the small canyon half a mile to the south, *situated a short distance farther down the western slope of the dome, struck water only in the sand. It seems probable that in this locality the small secondary fold has brought about a local accumulation of oil that does not extend beyond the limits of this fold.* Oil was reached in the open well in Oil canyon[6] at a point somewhat lower on the anticline than the well last mentioned, which obtained water, yet the old Bothwell well, drilled on the same contour of the dome, did not strike oil in the Dakota. Oil seeps occur in the Dakota sandstone near the point where its outcrop crosses Salt canyon, and also considerably to the east, near the head of one of the small branches of the same canyon, but *it is to be noted that no seeps occur east of the axis of the anticline.* * * * It seems probable, then, *that the possibilities of the Dakota sandstone in the Powder River field will not have been thoroughly tested until wells have been put down on the north and south ends and at some point on the east side,* preferably at locations such as the minor roll which is present * * * on the northeastern slope of the dome. * * * A table of analyses of Powder River oils, made in the laboratory of the United States Geological Survey under the direction of David T. Day, is appended. Analyses of the oils from Salt Creek and Lander are also given for the sake of comparison. Concerning the character and value of the Powder River oils, Dr. Day says: 'These oils resemble the heavy oils from Natrona county, but are somewhat different in their character, containing very considerable amounts of asphalts, while the Salt Creek oils show none. The samples here submitted show less than 2.5 per cent. whereas the Lander oils run as high as 15 per cent.'"

The writer believes that the absence of the naphtha, gasoline, benzine fractions, the low percentage of paraffin and the high percentage of asphalt reported in the preceding analyses of the Lander oils, which come from the Chugwater-Embar zone, is due in part to the extreme porosity of the Chugwater formation which would permit the lighter portion of the oil containing a large percentage of paraffin to become widely diffused throughout this formation both vertically and horizontally. The Lander anticline has been deeply eroded, and, as evidenced by numerous large oil springs and some rather large brea deposits, the portion of the lighter oil once collected and some of the heavier oil of asphalt base have escaped from the reservoir. If this oil had not been modified by a loss of the lighter portions, an oil of mixed base, high in paraffin compared to the percentage of asphalt, and similar to the oils found at practically the same geologic horizon in Oklahoma, would probably be found in the Lander field.

[2]U. S. G. S. *Bull.* No. 471-A, pp. 67-71. (The italics added by present author.)

[3]See second analysis from Powder River field.

[4]See third analysis from Powder River field.

[5]See fourth analysis from Powder River field.

[6]See first analysis from Powder River field.

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Well or location.	Physical properties.			Distillation by Engler's method.													
	Gravity at 60° F.		Color.	Begins to boil.	By volume.							Water.	Sulphur.	Paraffin.	Asphalt.	Unsaturated hydrocarbons.	
	Specific.	Baumé.			To 150° C. (naphtha, gasoline, benzine).		150-300° C. (water-white oil).		Residuum (lubricating oil, paraffin, and tar).		Total cubic centimeters.					Crude.	150-300° C.
					Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.	Cubic centimeters.	Specific gravity.							
Lander field.		°		°C.								P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
Wyoming No. 3		22.2	Dark brown.	93	2.5	.....	22.0	(a)	(a)	(a)	(a)	.....	.....	(a)	(a)	50.4	(a)
Wyoming No. 4		23.4	.....do.....	120	2.0	.....	23.5	0.8041	69.9	0.9543	95.4	.....	.....	0.91	4.02	46.4	4
Wyoming No. 5		23.5	.....do.....	93	2.0	.....	21.0	.8067	75.2	.9589	98.2	.....	.....	1.27	5.69	50.8	4
Wyoming No. 6		23.4	.....do.....	105	1.5	.....	24.0	.8018	73.9	.9605	99.4	.....	.....	.90	11.04	58.0	4
Wyoming No. 7		24.0	.....do.....	108	2.5	.....	23.0	.8047	73.1	.9589	98.6	.....	.....	.62	15.26	50.8	9
Salt Creek field.																	
Dutch No. 1 (sample 1)		40.3	Green.....	76	8.0	.7220	38.0	.7881	49.3	.8963	95.3	.....	.....	4.97	.....	16.4	4
Dutch No. 1 (sample 2)		39.6	.....do.....	76	11.0	.7210	36.0	.7934	50.0	.9088	97.0	.....	.....	4.91	.....	13.2	4
Dutch No. 1 (sample 3)		40.3	.....do.....	66	16.0	.7114	29.0	.7911	52.4	.8861	97.4	.....	.....	6.44	.....	14.4	5
Shannon No. 10		23.9	Olive green..	204	.....	.....	12.5	.7673	86.9	.9192	99.4	.....	.....	1.14	.....	15.2	6
Shannon No. 12		24.1	Green.....	213	.....	.....	10.0	.8673	86.6	.9211	96.6	.....	.....	.....	.....	14.8	8
Iba		38.4	.....do.....	84	11.0	.7215	34.0	.7875	54.0	.8923	99.0	.....	.....	5.56	.....	13.2	4
Stock		33.5	Dark green..	126	1.0	.....	36.0	.7854	62.4	.9032	99.4	.....	.....	5.63	.....	13.2	4
Powder River field.																	
Open pit in Oil Canyon		22.5	Black.....	190	.....	.....	14.0	.8546	84.3	.9302	98.5	0.19	0.38	.0	2.31	33.2	6
Oil seep in Salt Canyon		24.6	.....do.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.27	.....	.....	.....	.....
Tunnel in Salt Canyon		23.75	.....do.....	240	.....	.....	16.5	.8498	80.6	.9226	99.5	2.42	.55	3.12	2.30	27.2	8
Open pit in Trail Canyon		23.0	.....do.....	210	.....	.....	20.5	.8541	78.7	.9356	99.3	.10	.38	.0	2.58	31.6	8

a Flask broke during distillation. Water in the oil.

TABULATION OF ANALYSES.

Of the Salt Creek oils, the analyses of the Dutch, Iba, and Stock samples represent the character of the original oil stored in the Salt Creek dome, while the Shannon oils have been modified in part by the escape of the lighter fractions, due to the opening of the oil-sand by erosion.

The analyses of the Powder River oils indicate that the exposure of the oil-sands by erosion at this locality has resulted in the escape of the lighter portions of the original oil stored in the various oil horizons of this structure. This oil also has suffered modification by oxidation, and, while classed as an asphaltic oil, in all probability the samples obtained for analysis do not in any way represent the composition of the oil as originally collected in the structure.

By a study of the outcrop of the various oil horizons along the limbs of the anticlinal structures of central Wyoming, and by testing samples collected with the usual solvents, the writer has determined the following facts:

First—With the exception of a few places where small local structural features have retained a little oil which is now finding its way to the outcrop of the sands in the form of small seeps, the Shannon and Wall Creek sands at their outcrops are usually barren of any indication of petroleum. Only in an occasional sample was it possible to detect a trace of oil. It is evident, then, that subsequent erosion, evaporation, capillarity, oxidation, artesian waters, and other agencies have succeeded in extracting all but the last trace of oil from most of these sand exposures, thus leaving the present outcrop free to become charged with any waters which may come in contact with them.

Second—What has been said of the small oil seeps along the outcrop of the Shannon and Wall Creek sands is also true of those found in the Dakota sand. Bunches of tar and so-called 'tar springs' were noted at many localities in the Dakota. Analyses of several specimens of this tar showed it to be largely asphalt, although some samples yielded small amounts of paraffin scale.

Numerous wells drilled down the dip from the exposed oil-sand outcrop in various localities throughout central Wyoming have proved conclusively that Wyoming oils of paraffin base containing a small percentage of asphalt do not seal the sands sufficiently to retain the oil in commercial quantity. It should be added that the average proportion of asphalt found in numerous samples of California oils from localities where the sand outcrops are sealed is usually above 40%. Failures similar to those described above have been observed by the writer in Oklahoma, Illinois, Montana, northern California, and Alberta, Canada.

From the data at hand it is evident that Tertiary oils commonly contain larger percentages of asphaltum than the older oils. Consequently, in selecting sites for test wells in localities where the strata are probably saturated with water, and where the older oils of probable largely paraffin base are to be dealt with, it is advisable to shun areas adjacent to the exposed sand.

Working drawings on limp linen are used for all field work on the new Welland Ship Canal now being built between Lakes Erie and Ontario in Canada. Those drawings which are apt to be needed in the field are printed, brown or black on linen and are then colored, if desirable, to indicate any peculiar conditions. These linen sheets can then be crumpled into any convenient shape and carried, without much regard to their folding, in pocket or bag. They have proved very useful on account of their long wear, their freedom from creasing, and the ease with which they can be held and studied in wind or rain.—*Engineering News.*

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'Unit-Cast' Concrete Mill Building

By D. C. FINDLAY*

The great superiority of the 'Unit-Cast' type of construction, where duplication of units occurs, over the old method of formwork and casting in position, has been demonstrated by several notable structures in the last few months. The following article deals with a type of construction designed to overcome several serious difficulties in the matter of using ordinary methods of concrete construction.

The building is of the 'saw-tooth' type and the portion built of 'unit' construction measures 18 ft. 9 in. by 18 ft. Referring to Fig. 1, which shows a sectional elevation, it will be noted that the total height from floor to bottom of beam is 27 ft. 3 in., which height

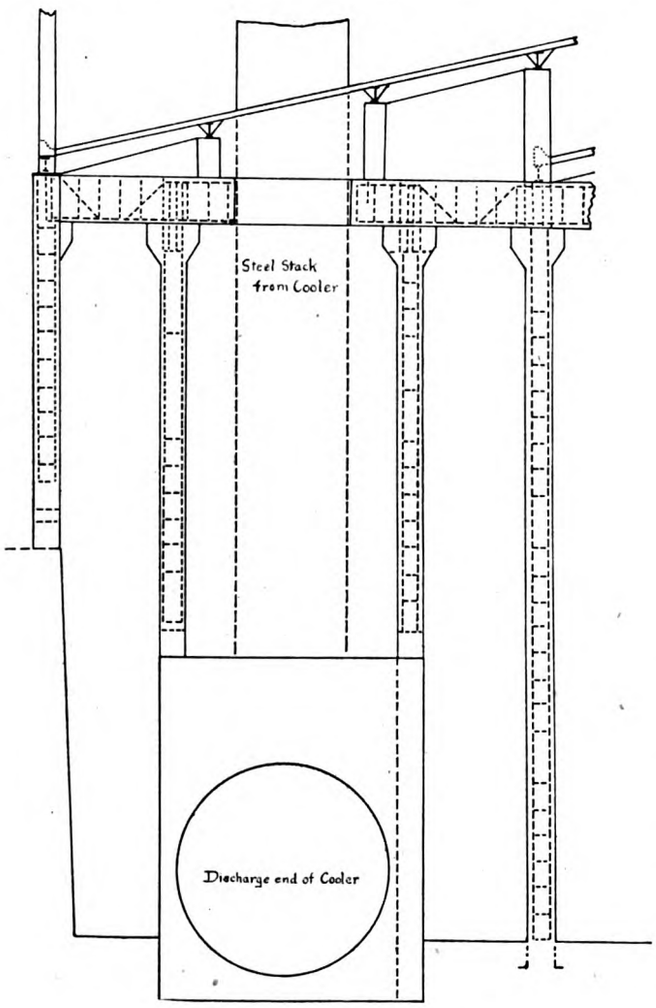

FIG. 1. SECTIONAL ELEVATION.

alone would require rigid posts to support the forms. In addition, it was necessary to keep the two rotary coolers shown in section, in continuous operation, and as they were handling 'clinker' from the rotary kilns at a temperature of probably 1500°F., the use of timber forms close to the shell was not permissible, and the third reason was that a railway track between the two coolers had to be kept clear and in steady operation. It was decided to construct the various members on a casting floor outside of the building and erect them in position as with square timber.

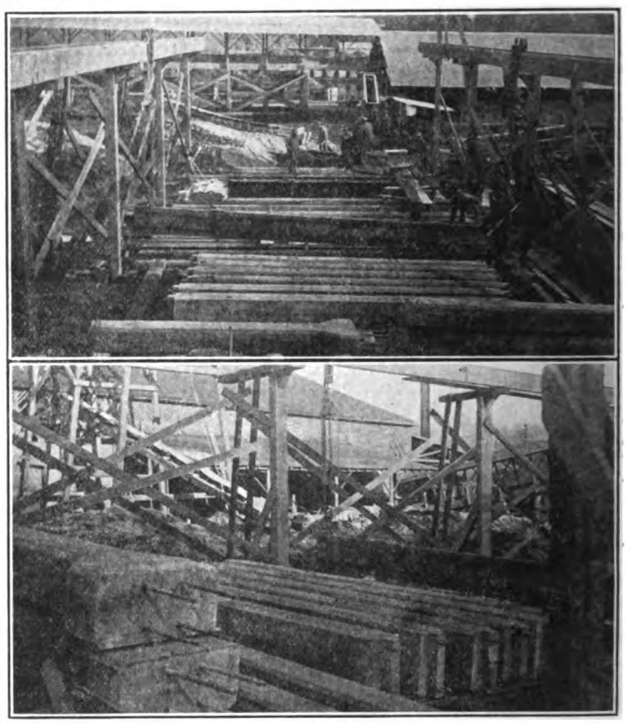

FIG. 2 AND 3. VIEWS OF CASTING FLOOR.

A casting floor approximately 30 ft. wide and 100 ft. long was carefully leveled up and built of tongue and grooved dressed lumber 2 in. thick and a special type of 'telpher' track was built on each side of the casting floor to handle the long beams and columns.

Fig. 2, 3, and 5 show different views of the casting floor and track. The latter consisted of bents spaced 18 ft. centres carrying a timber, on top of which was spiked a 20-lb. rail. On this rail ran a two-wheeled carriage having grooved wheels overhung on a ball-bearing shaft to which was attached a frame carrying a 5-ton chain block. A 29-ft. length of 7⅛-in. 'H' section steel was used to attach the chain blocks at either end. By lifting a 'unit' high enough to clear the other forms, using steel bars inserted in holes left in the concrete, it was easily run out on the track to the storage yard. When a 'unit' was wanted from the yard a similar procedure was used. A motor driven ½ yard Ransome concrete mixer was located at one end of the floor high enough to allow the concrete 'buggies' to run on plank

*Mount Tolmie road, Victoria, British Columbia.

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on top of the 'unit' forms. Sand and gravel were scraped off scows and deposited at the mixer. Fig. 4 shows details of the removable forms for casting the beams and columns and a detail of the design of the beams and columns. The beams were made 1 ft. by 1 ft. 9 in. by 18 ft. 5 in. long and reinforced with three ¾-in. bent and two ¾-in. straight bars hooped every 12 in. The ends of the bars projected 1 ft. 6 in. beyond the head of the column. The beam steel projected 2 in. at each end. One-inch holes were made in the beams and columns near the ends as shown, for lifting purposes and two ¾-in. bolts threaded at both ends were cast into the column for attaching 4 by 4-in. angle irons. The forms were made easily collapsible and were held in place by the ½ by 3-in. irons shown slipping into holes in the floor. This held the forms always in rigid alignment and ensured straight columns. Reinforcing steel was made up, securely tied, and placed in position as a unit.

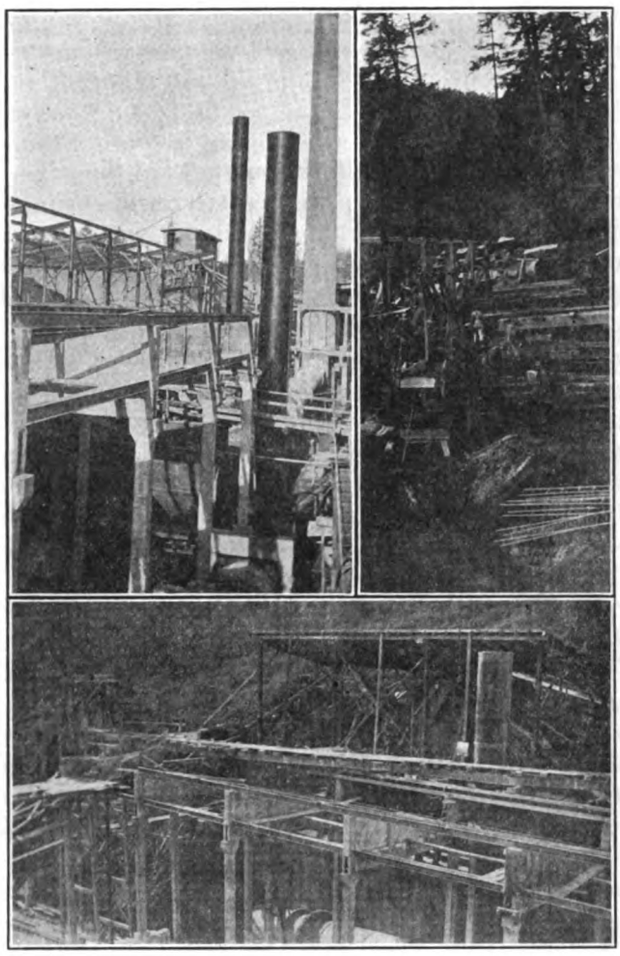

FIG. 5, 6, AND 7. VIEWS OF CASTING FLOOR AND OF ROOF PURLINS.

A 1:2:3 concrete was used for the columns and beams. By casting the 'units' horizontally, careful tamping of the concrete was assured and the finished 'unit' was free from defects. The concrete was allowed to set 7 days on an average before being moved into the storage pile, remaining there till ready to be erected. The footings for the columns were excavated and concrete poured in place to 1 ft. below floor grade. Four ¾-in. bolts were then set for attaching the 4 by 4-in. angle irons. The columns were erected by a gin pole and hand winch, as the site was too crowded to permit using a derrick. The gin pole was also used to pick the beams up by the middle and set them on top of the columns. Before landing in position, a thin layer of mortar was placed on the head of the column to form a uniform seat, and a form was placed around the joints. The projecting column, beam steel, and the dovetailed ends of the beams were grouted in with a wet 1:3 mixture.

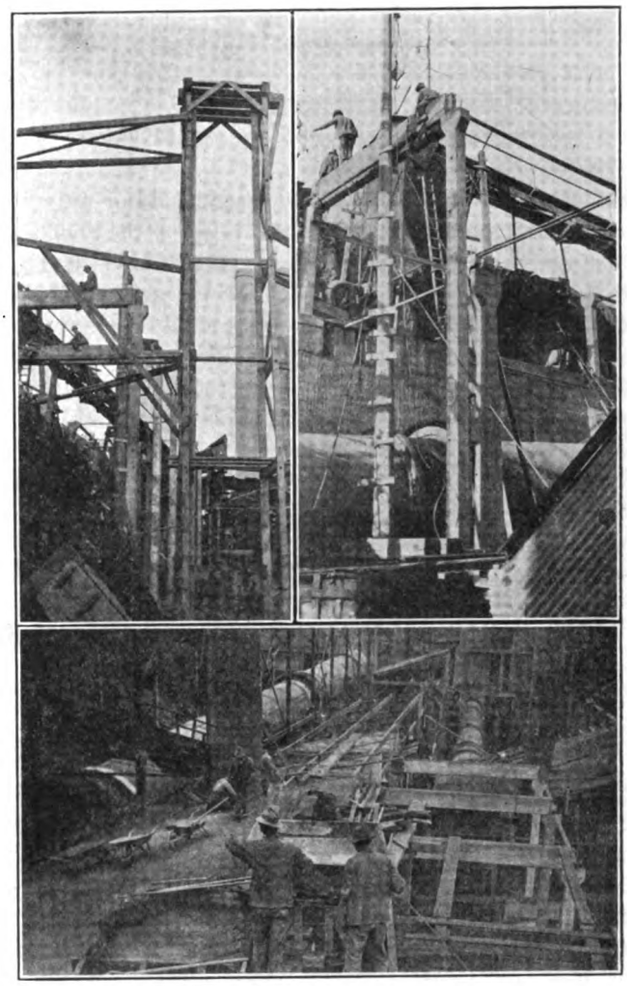

FIG. 8, 9, AND 10. VIEWS OF BUILDING DURING CONSTRUCTION.

After the beam was in place a collapsible form was set upon it and the roof truss was poured in place. Fig. 1 shows details of the truss. It consisted of three buttresses 10 by 12 in. connected by a 3-in. reinforced wall. Anchor bolts were set for attaching the 8-in. I beam purlins to carry the roof slab. These buttresses were bonded to the beams by ¾-in. dowels grouted into holes in the beam. Fig. 6 and 7 show the roof purlins in place for one section. The forms for the roof slab were made in sections and were carried by the bottom flanges of the I beams. By beveling the ends,

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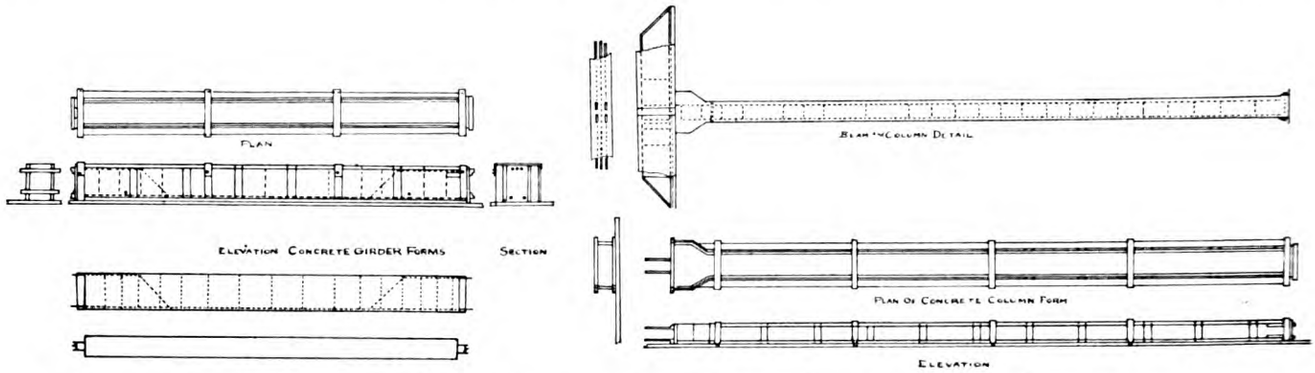

Fig. 4. Details of forms, beams, and columns.

the web of the I beam was encased, leaving only the bottom flange exposed. The concrete for the roof slab was mixed at the casting floor and hauled in 1-yd. Koppel side-dump cars by an electric winch to a tower at the edge of the building. A second winch picked up the car and a section of track and elevated it about 35 ft. to the level of a track on the roof, where the concrete was dumped into a box and distributed by wheelbarrows. Fig. 7 shows this tower and track and Fig. 8 shows a car of concrete being dumped. The roof slab was 3½ in. thick and was finished with ½ in. of a 1:2 mixture and troweled smooth. A concrete rain gutter was molded in place, with a slope toward the edge of the building. This type of construction eliminates practically all form work and waste of lumber, as the beam and column forms were used over repeatedly, as were the forms for the roof truss and the collapsible roof slab forms. Attention is called to the method of carrying the columns affected by the cooler. Excellent results were obtained at a cost of about 70% of the estimate on a similar job where the beams and columns were built in place. The work was designed and erected under the direction of D. C. Findlay, for the Vancouver Portland Cement Co., Victoria, B. C.

The Water Problems of the San Joaquin Valley*

By G. McM. ROSS†

These problems involve the care of the rivers, the promotion of navigation, the storage of water for irrigation, flood control, reclamation and drainage.

The navigation of the San Joaquin river formerly extended south to Firebaugh in Fresno county, a distance by river of nearly 275 miles from Stockton. Now the head of occasional navigation is at Grayson, 62 miles by river south of Stockton. In the early settlement of the San Joaquin valley regular freight and passenger service by river steamers to Firebaugh was a feature of the life of our people. Stockton is now practically the head of continuous navigation in the San Joaquin valley. From that city to deep water there is a great and increasing commerce. We have, however, lost 275 miles of navigable waters that possibly can be recovered; with this object in view, a survey has just been made. The problem of the navigation of the San Joaquin has yet to be solved.

On the Eastern edge of the San Joaquin valley, we have provided storage for a small percentage of our rainfall; not more than 10%. We are now irrigating less than a million acres—we have still ten million acres that are not irrigated. It may interest the non-farming members to know that five of the irrigation districts of the San Joaquin valley have perfected plans for the irrigation of 524,000 acres—that these lands are susceptible of intensive cultivation; on such lands the minimum vegetable growth is twelve tons per acre per year, or for these five districts, six and a quarter millions of tons; the maximum production has not yet been determined, but it can safely be put at three times that amount. Irrigation experts tell us that even when we have stored all of our rainfall that we cannot irrigate for intensive cultivation more than half of the land that could be made productive by irrigation. The small storage now in use affords a little protection against floods; this is, however, but an incident in our irrigation project. We have done nothing to control our flood waters except to build levees on our delta lands.

In reclamation, the delta lands of the San Joaquin valley, comprising approximately 300,000 acres, are all reclaimed or are now being reclaimed; when these reclamations are fully insured against damage by flood waters, they will be among the most productive and valuable agricultural lands in the world. In drainage, except as part of the necessary work of reclamation, we of the San Joaquin valley have done nothing. We have a vast body of rich land—Tulare lake—the drain-

*Address delivered before the Inland Waterways Congress at San Francisco, March 23-25, 1915.

†Stockton, California.

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age of which would make available 640,000 acres of as rich land as there is in the state. This lake when filled with flood waters covers a thousand square miles; it has been full, within the memory of men now living. In 1906 a grain crop was growing in the lowest part of the lake bottom. In 1907 the flood waters again appeared and covered three hundred square miles of territory, and where grain was growing the year before, was covered with over fourteen feet of water. It is possible to drain Tulare lake without injury to the reclamation projects in the delta lands and with positive benefit to the river; it is also possible to prevent the flooding of the lake lands by building storage reservoirs in the mountains east of the lake. No crops need be lost in Tulare lake, nor need the land remain unused even for one season.

All of the water problems of the San Joaquin valley are still with us. They are still inviting solution. Their practical solution seems to be in sight, as the necessity for source control of our rivers and streams and its positive value becomes clearer and clearer in the minds of our people. When they are willing to accept the principle of source control, navigation will be aided and extended by standardizing the river flow; irrigation will reach its maximum development; reclamation will be insured, and drainage will be reduced to a minimum, and electrical power can be generated from the stored water while on its way to irrigate the valleys and to standardize the flow of the rivers.

Among the results obtained in working out the details of irrigation, is the unusual feat of establishing a just and equitable means of levying taxes and assessments, to cover irrigation costs. This has been done in the Modesto and South San Joaquin districts by assessing the land only, exempting all improvements. That this means of assessing costs is equitable, is testified to by the bankers who now cheerfully take as security the bonds of the irrigation districts of the San Joaquin valley. The officials of the irrigation districts, the Chambers of Commerce, and the Building Trades Council all testify that the system is equitable. Some of these people intimate that a full application of their system of taxation of land values will lead the world to economic justice, industrial peace, and into a pure democracy where the equality of opportunity is to remain forever.

The Relation of the San Joaquin Valley to the Inland Waterways Association.—The reason given by those in authority for our existence as a body is that "the purpose of this organization shall be the furtherance of navigation by means of inland waterways and the improvement of harbors and the investigation, co-ordination, and promotion of navigation, water storage, flood control, irrigation, drainage, reclamation, and kindred subjects."

Our worthy president, D. L. Beard, in declining to take part in a recent controversy, said "If the proponents of the reclamation work being carried on by the board would realize fully that their work is a project definite and positive, that the Newlands-Broussard bill is a principle pure and simple, providing fixed revenues for carrying out the projects in general, I believe that the entire matter would be adjusted and there would be no more friction between the proponents of the two propositions." For years, we of the San Joaquin valley have been and are still advocating the passage of the Newlands bill and later the Newlands-Broussard bill, as we contend, that the measure contains a principle that will when we adopt it, solve all of our water problems, while at the same time it will control the destructive flood waters of the nation and will insure the just, safe, and prompt development of the resources of our state. Therefore, we the members from the San Joaquin valley, are contending for a principle, not a project. The principle that we are contending for is the safe, sane, and just development of our state; we are struggling to make this principle as clear as the Declaration of Independence and as complete as the Constitution of our country. We are insisting upon the adoption of a principle for the solution of all of our water problems, a principle that, while great enough to include the interest of the nation, and of the state, will at the same time perfectly safeguard the interest of any community, and the rights of our poorest citizen, not by favor or concession, but by right of equal partnership; a principle that provides for the co-operation of every interest in our country, national, state, municipal, and individual.

We, as a people, do not seem to have discovered a means of promptly securing from our legislative bodies, national or state laws that embody principles. Our weakness in this respect is made clear by a study of our regular recurring annual losses from uncontrolled flood waters. Our lowest estimate of such loss reaches hundreds of lives, and one hundred millions of dollars worth of property. This is permitted to continue year after year, in face of the fact that a principle of control has been offered, and generally accepted by those competent to pass upon such matters, and yet the years continue to pass, and we as a people have done practically nothing to prevent such an appalling loss of life and property. It is full time that we paused long enough to assure ourselves that a proper principle will care for every worthy project.

It is not an uncommon thing to find steam shovels and other equipment which must be left standing on the job during the winter months, partly or wholly uncovered and exposed to the weather. The harm that results from this practice need not be emphasized. Any engineer will see that the boilers are drained, that the bright metal parts are greased and the brass fittings, valves, lubricators, etc., are taken off and stored away to prevent their being stolen. It is important, however, to board over as much of the machine as possible. When it is not possible to do this, heavy tarpaulins may be tied around the exposed parts.—*Excavating Engineer.*

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Gauging of Sewage Flow, Berkeley, California

By T. A. BITHER*

In the fall of 1911 the council of the city of Berkeley approved the plan of city engineer J. J. Jessup to install a weir at one of the sewer outfalls to obtain data on sewage flow, to be used in the design of the new system of sewers installed during 1914. In the design of sanitary sewers the general method is to compute the necessary size from data available on the water consumption of the community for which the sewerage system is intended, it being customary to assume that the daily water supply of a place is all converted into sewage. This is not an accurate method, since the flow of sewage and the consumption of water vary widely. Where possible, the correct method of obtaining the necessary data for the design of a system of sewers is to determine the amount of sewage for that particular community by actual measurement of flow from some district the population of which is known or can be determined. The information thus obtained is also valuable in the solution of problems in sewage disposal, but in this case it is also necessary to determine the composition of the sewage and the character and amount of sludge.

The 16-in. outfall at the foot of Folger avenue was chosen as the best site for the weir. The district tributary to this outfall included that portion of Berkeley south of Dwight way and east of San Pablo avenue, with the exception of a small district between Dwight way and Ward street west of California street. To this must be added the houses on both sides of Folger avenue west of San Pablo avenue. That portion of the district west of Sacramento street was rather sparsely

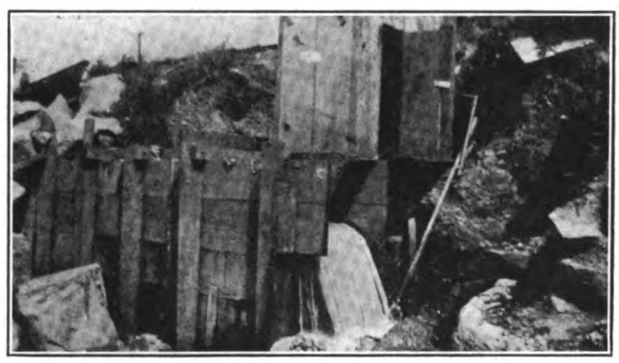

FIG. 1. VIEW OF WEIR.

settled, due to late improvement, but east of Sacramento street 90% or more of the lots were built upon. The section is residential, the character of the inhabitants varying from factory workers in the western part to those in better circumstances in the eastern part, where are found some of the most beautiful homes in Berkeley. The measuring device consisted of a box 4 by 5 ft. by 8 ft. 6 in. built of 2-in. redwood and placed perpendicular to the sewer outfall. At the south end of the box was a 2-ft. suppressed weir with a sharp steel crest 3 ft. above the bottom of the channel of approach, which was 3 ft. long and 2 ft. wide. The sewer entered the box at the north end, the centre of the pipe being 13 in. from the end and 28 in. above the bottom. The sewage passed through three baffles to reach the weir, two horizontal and one vertical. The float chamber, 2 ft. square, and the still-box were on the east side of the channel of approach. A flush gate at the north end opposite the sewer inlet was used two or three times a week to flush the sludge out of the box. The 16-in. sewer along Folger avenue was constructed on a 1% grade, which gives a maximum discharge of 8.5 cu. ft. per second, so the weir was built for a capacity of 9 cu. ft. per second.

The automatic recording device shown in Fig. 2 was constructed in the shops of the department of civil engineering of the University of California. The vertical drum is 24 inches in length and 22 inches in circumference, and is so geared to the clock that it revolves at a rate of 1/8 in. per hour. The complete revolution was made in about seven days, the record sheet being changed every week. The pencil carried by the float rod is held against the drum by a spring, so that a curve is drawn upon the record sheet. By reference to a datum line drawn on the sheet when it is placed on the drum, the curve gives the head on the weir at any time. This datum line is drawn by revolving the drum with the pencil bearing on the paper and the clock mechanism disconnected. The height of the datum line above the weir crest is determined by a hook gauge.

The records obtained cover the period extending from March 1912 (the date of completion of the weir) to March 1913. During this time all conditions of flow were experienced, from the extreme dry weather flow to the high rate during and immediately following rain storms, at which times the sewer was taxed to its capacity. The weir was designed and constructed under the direction of E. A. Ingham, who took the records for March 1912. The writer had charge of the weir from April 1912 to March 1913. The work was carried on under the direction of Prof. C. G. Hyde, of the University of California.

The rags and paper in the sewage caused considerable annoyance by clogging the baffles. It was thought that this clogging could be prevented by placing a screen in front of the baffles. A vertical bar screen was constructed and placed in the box, but was removed in a short time, since it was seen that the clogging of the screen caused more trouble than had before been experienced by the clogging of the baffles. Frequent

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cleaning of the baffles with a rake was the only method of doing away with this annoyance. The sludge which collected in the box was removed by pushing it out through the flush gate with a squeegee. The clock mechanism used to revolve the drum bearing the record sheet was a constant source of trouble. The exposure to the salt air caused the works and especially

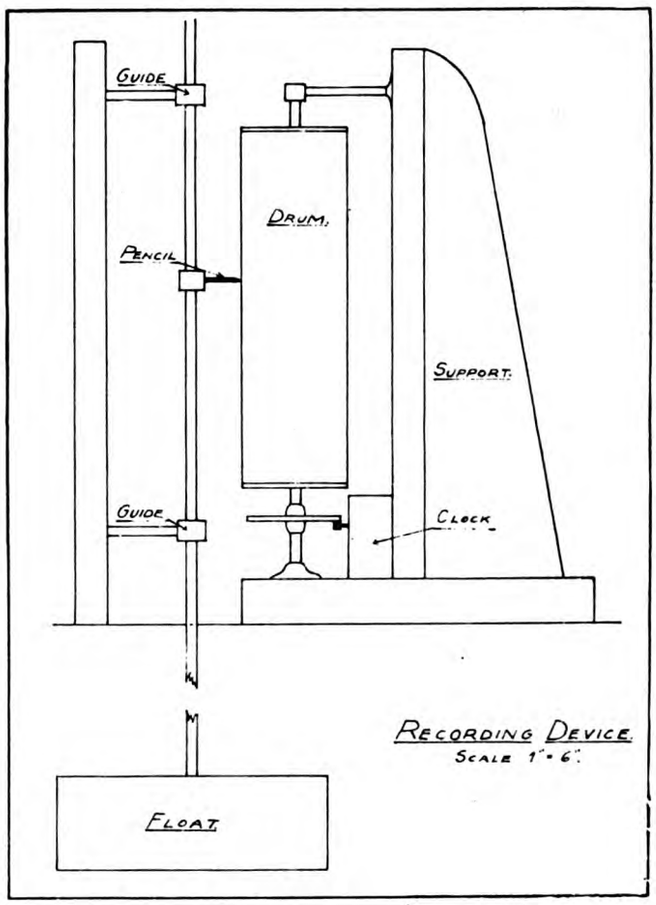

FIG. 2. SECTIONAL VIEW OF RECORDING DEVICE.

the steel springs to corrode, and it was necessary to clean the works often and to keep them well oiled. A duplicate clock was provided to avoid interruptions of the record.

In computing the discharge over rectangular weirs, it has been found that for heads varying from 0.07 to 0.50 ft., the formula of Fteley and Stearns gives the most accurate results, while for heads above 0.50 ft. the Francis formula should be applied. The formulas are given below.

Fteley-Stearns formula—

$$Q = 3.31\ L\ H^{3/2} + 0.007\ L$$
$$H = h + h_v \cdot 1.5$$

Francis formula—

$$Q = 3.33\ L\ H^{3/2}$$
$$H^{3/2} = (h + h_v)^{3/2} + h_v^{3/2}$$

Notation:

Q = discharge in cubic feet per second.
L = length of crest.
H = head corrected for velocity of approach.
h = observed head.
h_v = head due to velocity of approach.

For the case in hand, these two formulas were applied in the computations for discharge. It was necessary to correct for velocity of approach. Although the weir crest was 3 ft. above the floor of the box, the channel of approach was taken as 2 ft. deep, to allow for sludge to a depth of 1 ft. under the crest.

Typical record diagrams are shown in figures 3, 4, and 5. Fig. 3 is the record for September 27, 1912, a typical dry weather record. Fig. 4 is a typical wet weather diagram, that for January 21, 1913. Fig. 5 is a rainy day record, that for May 21, 1912. On this day 0.23 in. of rainfall was recorded by the University of California gauge. The sewers of this district were designed to carry house sewage alone, and no rain water was supposed to enter them except through manholes or by seepage. Nevertheless, every rain immediately in-

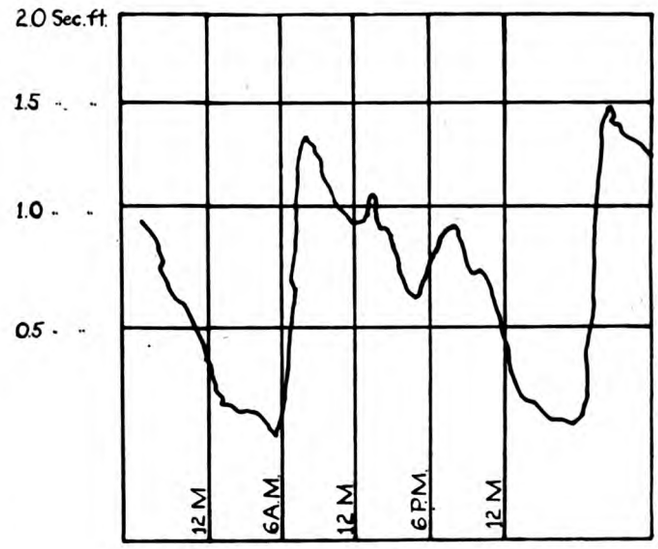

FIG. 3. RECORD FOR SEPTEMBER 27, 1912.

creased the discharge of the sewer, showing that rain water found its way to the sewer by a more direct route than either of the above. This was accounted for by the connection of roof drains to the sewer which had been made in many places contrary to the city ordinance prohibiting such connections. The similarity of the record diagrams is very noticeable. For days with flow uninterrupted by rainfall, the fluctuation of flow during the 24 hours follows the same cycle each day. The flow is a minimum early in the morning, about 4 a.m. to 6 a.m. There comes then a sudden increase to the maximum for the day, which occurs between 8 a.m. and 10 a.m. The flow then decreases slowly until about 5 p.m., when it begins to increase again, reaching a maximum at 8 p.m., after which it decreases to the early morning minimum. An examination of the records for various days shows a maximum flow on Monday and a minimum flow on Sunday with very constant daily flow for other days of the week.

By taking off the maximum ordinate and minimum ordinate from each day's record diagram the maximum

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and minimum flow for that particular day was determined by means of a head-discharge diagram. From the area under the curve the average ordinate was computed, and from this the average flow for the day was deter-

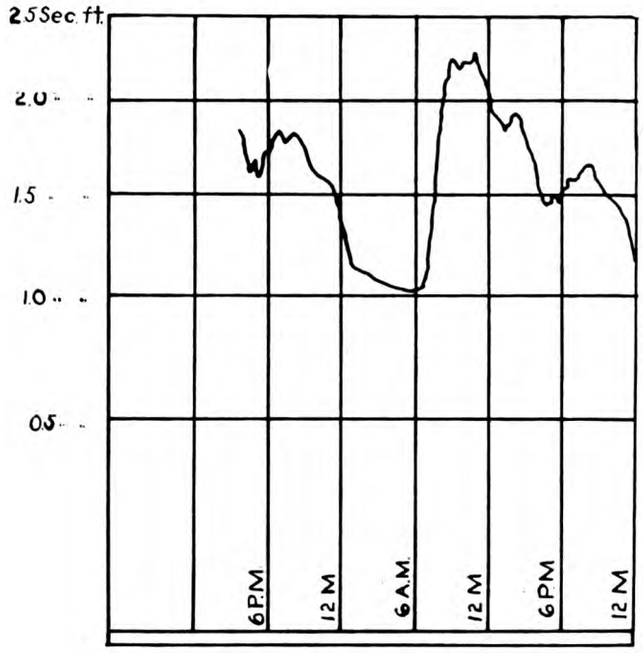

FIG. 4. RECORD FOR JANUARY 21, 1913.

mined. The following results were obtained by omitting all rainy day records, of which there were 47. It was found that the

	Gallons per 24 hours.
Average flow for year	639,000
Maximum flow	912,000
Minimum flow	472,000
Percentage of maximum over average	42.8
Percentage of minimum under average	26.6

	Cubic feet per second.
Maximum rate for any day	2.1
Minimum rate for any day	0.2
Average rate for all days	0.99
Percentage of maximum over average	112
Percentage of minimum under average	80

The population of the district was determined by a thorough canvass in which all dwellings, stores, schools, industrial establishments, etc., were counted. The 'persons per dwelling' factor for Berkeley was taken from the thirteenth U. S. census and the population was found to be 19,000. From this and the above results

	Gallons per 24 hours.
Average flow per capita	33.7
Maximum flow per capita	48.0
Minimum flow per capita	24.8

The total number of connections in the district was found to be 4844.

	Gallons per 24 hours.
Average flow per connection	132.0
Maximum flow per connection	188.5
Minimum flow per connection	97.5

The average consumption of water for the city of Berkeley as determined by the Peoples Water Co. was 50 gallons per capita per day.

Average sewage flow per capita = 67.5% water consumption.

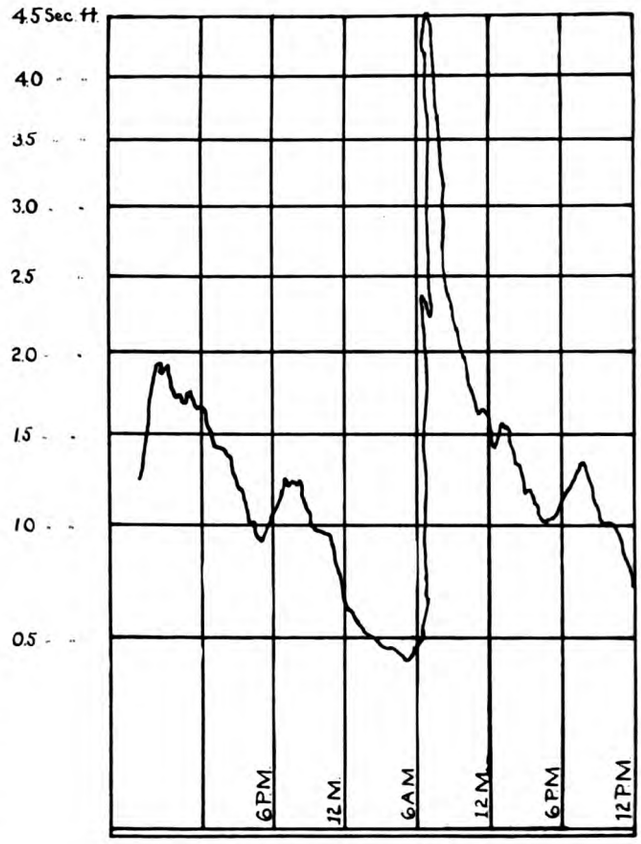

FIG. 5. RECORD FOR MAY 21, 1912.

The following table gives the lengths of the various sized sewers as scaled from the Berkeley sewer map.

	Miles.		Miles.
6-in. sewer	22.2	14-in. sewer	1.2
8-in. sewer	13.6	16-in. sewer	0.7
10-in. sewer	2.5		
12-in. sewer	0.8	Total	41.0

Average flow per mile of sewer = 15,600 gal. per 24 hours.

Since there is little water used about 4 a.m., the minimum daily flow which occurred at this time was accounted for by water reaching the sewer from leaky fixtures and seepage through joints in the sewer pipe. During the dry season the amount reaching the sewer by the latter means is so small that it can be neglected, and the minimum flow can be considered to be all leakage. So the amount of seepage can approximately be determined by taking the difference between the minimum wet weather flow and the minimum dry weather flow.

Minimum wet weather flow, cubic feet per second	0.8
Minimum dry weather flow, cubic feet per second	0.2
Ground water seepage, cubic feet per second	0.6
Ground water seepage, gallons per 24 hours	388,000
Ground water seepage, gallons per mile per 24 hours	9,500

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Samples of the sewage were taken at different times from which the total solids, suspended solids, character and amount of sludge were determined.

Total solids, parts per million	1,160
Total solids, grams per capita per day	120
Suspended solids, parts per million	272
Suspended solids, grams per capita per day	35
Amount of sludge, cubic centimetres per litre	8.8

The sludge was composed of fecal matter, rags, pieces of paper, sticks, fruit, vegetables, peelings, foul entrails, matches, worms, pieces of rubber, coffee grounds, and dead rats.

The Value of the Water Resources of California to Its Chief Port*

By C. E. GRUNSKY†

Perhaps I had best start out by saying that without water resources there could have been no material development in this state—that there would in fact have been no California. But nature has been kind and has here made provision for man's wants to an extent that was far from being realized by the early settlers. The water of the prehistoric rivers rolled along the gold-bearing gravels and left vast deposits in ancient river-channels from which the miner with the aid of water extracted the precious metal. The younger rivers, too, had before the advent of the white man made their deposits from which the sluice-box and the dredge, always aided by water, drew great stores of wealth. The same waters which concentrated the gold at the points where it is found in the sands and gravels of the mountains and foothills acted as agents in cutting down the mountains and carrying seaward the detrital matter which has gradually built up the fertile lands of California's valleys. Without water there could have been no fertile valley. And yet I am asked to say something of the economic value of the water resources of California; for there are real values to be noted and potential values of vast magnitude. The value of the water resources, let me say, grows as population grows. Their use is ever developing and no one can foresee the limit.

In their relation to San Francisco bay these waters may be divided into several classes. There is first the water that flows in the stream; second, the water which is temporarily stored by nature at high altitudes in the form of snow; third, the water which finds temporary or permanent lodgement in lakes; fourth, the water flowing or stored in subsurface pervious formations; and fifth, the water which fills the bay and its many estuaries.

A small portion of these waters is needed for domestic use. Despite the rapid growth of our population noted by the Census at 60% in the ten years from 1900 to 1910, and at 44% per decade since 1870, there will nowhere be any great difficulty in supplying this demand even when this country approaches the limit of population-density of which it is capable. Moreover, for this use there is available, and as yet barely brought under contribution, a vast high mountain collecting-ground from which water of exceptional purity and of most excellent quality is obtainable. To such a source this city looks forward, and from such a source the entire Bay region will some day receive the supply that will supplement the secondary nearby sources of water.

To a lesser extent but nevertheless of prime importance for domestic use are the subterranean waters which are annually replenished by the infiltration through surface formations of rain-water and stream-flow, and which are already being drawn upon, not alone for municipal supply, but also in rapidly growing amounts for irrigation. The mere statement of these general facts will suffice. It would be presumption to attempt to express in dollars the present value of such potential resources.

While there are considerable portions of California in which greater rainfall would be an advantage, nature has nevertheless been kind in making a utilization possible which in many respects is better than could be expected under conditions of larger rainfall and a more extended rainy season. Who would desire to shorten California's dependable long dry summer season? Better by far to be favored with this dry climate and the certainty of a good harvest season and something to harvest, than to have to contend with the uncertainties that obtain in regions where rain is to be expected in every month of the year. Even the arid conditions may be an asset, if, as is so generally the case in the central portions of this state which I have had assigned to me for discussion, there are water resources which can be drawn upon to supplement the winter rains.

An idea of the economic value of the water in increasing the output of farm products within the region tributary to the chief seaport of the state can perhaps best be given by a brief reference to what has already been accomplished by irrigation in the area which drains into San Francisco bay. The agricultural land and the land which had been brought under irrigation several years ago in this region was estimated by engineers connected with the United States Department of Agriculture at amounts indicated in the following table:

*Address delivered before the Inland Waterways Congress at San Francisco, March 23-25, 1915.

†Consulting engineer, Mechanics Institute Bdg., San Francisco, California.

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Valleys and plains.	Agricultural land.	Irrigated land.
Sonoma county	132,900	456
Lake county	47,000	622
Napa county	56,000	508
North-central mountain valleys	94,500	47,650
Northeast plateaus	256,900	64,100
Feather River valleys	158,000	50,600
Sacramento valley	4,449,000	123,500
Central coastal valleys	335,800	46,630
San Joaquin valley	7,576,000	1,728,975
Total	13,106,100	2,063,041

Of the 13,000,000 acres of land classed as agricultural in this region, but not including the rolling lands of the foothills, about 2,000,000 acres are reported to be irrigated. It is probable that about 6,000,000 acre-feet of water is diverted from its natural channel or withdrawn from subsurface sources by pumping or otherwise to accomplish this irrigation. But there remains 10,000,000 to 11,000,000 acres of valley lands and also a considerable extent of mountain and foothill areas yet to be brought under intense cultivation by irrigation. To much of this land water can readily be supplied, while other portions thereof are less favorably situated. With the growing value of the products of the farm and with the increasing value of the farm land, great development with the aid of irrigation is yet in prospect. Moreover—and this is the interesting fact in this discussion—there is an abundant supply of water yet unused. Taking the Great California Valley alone, there is an inflow of water into the same in a year of ordinary rainfall from the Sierras and the Coast range of some 36,000,000 acre-feet, and in a year of minimum rain about 12,000,000 acre-feet of water reaches the valley. By reason of a surplus of water at the north and a deficiency at the south, the abundance of the apparent supply is not as real as any such general statement as this of the volume of stream-flow would indicate. Nevertheless, it is interesting to note from such figures as already presented that even without recourse to storage, the available supply in a year of minimum water-production is in the aggregate about twice the amount now beneficially applied to the land, and that the mean annual run-off exceeds this amount about fivefold. There is, in other words, room for development, particularly when recourse is had to storage on a large scale which will aid in bringing into use the surplus of the year of abundant flow which now goes to waste. The value of the annual products of the 2,000,000 acres which are irrigated is probably $30 or more per acre greater than the products would be from the non-irrigated field. There is, therefore, due to the use of water for irrigation, some $60,000,000 more put into circulation annually in the region tributary to San Francisco bay than would be the case if no water were used for irrigation. Here are the means for the support of a population of more than half a million people with all the various vocations and occupations that contribute to the providing of the necessities and comforts of life.

This remarkable showing results from the fact that climate and topography and geology all contribute their share in making water available which under other conditions might have to be allowed to flow unused to the sea. On our mountain slopes the rainfall is abundant. Where the valley receives 5 to 20 in. as the average amount in various sections per year, the fall in the mountains of rain or snow, runs up, at some points, to 80 in. This abundant precipitation is in part stored in underground strata and reappears when most needed in the spring, summer, and fall in the form of springs, of which those which feed the McCloud river, those at the head of Fall river, and that on the north fork of the Feather river in the Great Meadows, recently converted into a reservoir, which sustain the summer flow of the Sacramento and Feather rivers, stand out as phenomenal examples. But yet greater is the benefit that comes from the fact that the precipitation at the high altitudes of the Sierra Nevada and in the northern portion of the Coast range is in the form of snow, which melts slowly, not only thoroughly saturating the pervious soils of the mountains, but keeping the streams at a fair stage in April, May, and June, in the very months when water is in greatest demand by the irrigator. This is a form of natural storage contributing to the equalization of stream-flow which has long ago been recognized as a valuable asset.

Furthermore, the topography of the watersheds of most of the mountain streams is favorable for artificial storage of water. This is particularly true of the northern portions of the upper Sacramento river and of Feather and Yuba rivers, but applies in some measure to all of the principal streams which drain the Sierra Nevada and the Coast range. To illustrate, the Tuolumne river may be cited as an example. The mean annual water output of this river is about 2,000,000 acre-feet, or over 2700 second-feet average flow. The river brings down most of this water within a few months in winter and spring. Most of it is at present waste flood-water. Its late summer and fall flow is insignificant. To accomplish complete regulation of flow on this stream, a storage capacity, properly located to command the watershed, of more than 2,500,000 acre-feet would be necessary. The investigations which have been made on this river indicate that the development of a storage of about 1,000,000 acre-feet may reasonably be expected at an expense warranted by the value of the water thereby made available. Storage in this amount on this river would make possible the utilization of nearly three-fourths of its total flow instead of about one-fourth as at present. Moreover, the stored water is available throughout the year, and as the storage-sites are for the most part located high in the mountains, the value of this storage for the generation of power, in addition to its value for irrigation, is obvious.

Attention should be called to the fact that it is difficult to set the limit upon the storage possibilities on any of our rivers; that is to say, where this limit is not fixed by stream-flow, for the reason that what is

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not economically feasible today may be feasible ten or twenty years from now. The time may come when storage in comparatively narrow cañons, where the cost per acre-foot of capacity is high, may be justified. In other words, the storage limit will go far beyond what today is regarded as feasible.

The developed power on the waters which are tributary to San Francisco bay may be approximately noted at 500,000 hp. When this figure is compared with the estimate made a few years ago by W. B. Clapp (District Engineer of the U. S. Geological Survey) of the total power represented by the water of the streams in this region, aggregating 5,300,000 hp., of which, if conditions for power-development were everywhere favorable, about one-half could be delivered for use, it will be seen that here, too, there is room for further development on a large scale, and that in addition to the benefits already conferred by the development of water-power, there is a great potential value in these streams that will be developed as the demand for power grows. Of special value to the state, and, of course, to no portion thereof more than to its chief seaport, is the development of this water-power. Not only is the power as valuable as power from any other source, with the industrial accomplishment which it makes possible and the comforts which it provides, but it results in the most ideal conservation of such resources as coal and oil. The water-supply is annually replenished by the radiant energy of the sun, through the medium of evaporation and rainfall. Other resources such as oil, when the store is exhausted, cannot be replenished. The encouragement of an early development of the water-powers of this state is a sane policy. The only safeguard required is reasonable regulation and a fair time limit upon all privileges of development, so that all power rights will revert from time to time to the people.

And now a word only on the subject with which this convention is specially concerned—the inland waterways. Some idea of their recognized commercial importance may be gained from the following figures representing the amounts appropriated by the United States government for the preservation and improvement of the navigable inland waters directly tributary to San Francisco bay and the tonnage transported over them. These figures are taken from the official report of the U. S. Engineers in charge of this river and harbor work. They do not include the additions to navigable waters which have been incident to the work of reclaiming the swamp lands of the bay and river delta region, or a relatively small amount expended by the state on the rectification of the rivers.

Appropriations by Congress for the Improvement of Harbors and Navigable Channels within the Watershed of San Francisco Bay (to and including 1913).

Sacramento river and Feather river	$1,133,942
San Joaquin river	911,813
San Francisco harbor	622,458
Oakland harbor	4,337,068
Redwood creek	46,443
San Pablo bay	1,153,168
Suisun channel	27,000
Petaluma creek	143,593
Napa river	61,974
Stockton channel and Mormon slough	280,403
Mokelumne river	31,000
Total	$8,748,862

Freight on San Francisco Bay and Tributary Waters, Year 1913

	Short tons.	Value.
Sacramento river and Feather river	733,594	$ 35,856,791
San Joaquin river	820,399	38,341,174
San Francisco harbor	9,353,550	539,980,306
Oakland harbor	3,413,980	183,441,743
Redwood creek	20,130	1,336,082
[1]San Pablo bay	2,483,051	48,192,957
Suisun channel	57,226	559,731
Petaluma creek	198,625	15,917,033
Napa river	222,938	5,742,408
[2]Stockton channel	.....	.....
Mokelumne river	90,585	5,059,932
Total	17,394,078	$874,428,157

[1]This does not include freight to Mare Island valued at over $10,000,000.

[2]Included in the amounts noted for San Joaquin river.

Whether there is much or little navigation on the two principal rivers of the state—on the Sacramento as far as Red Bluff and on the San Joaquin as far as Fresno slough—the fact remains that these rivers, together with the network of delta channels, natural and artificial, have been powerful factors in the development of the central portions of California. Hundreds of craft are already navigating these waters. The products of some 500 square miles of delta lands, the cash rental value of some of which is as high as $25 per acre per year, have been added to the products of the valley up-lands and are brought to our doors at the low transportation cost made possible by these waters.

The largest chain-drive transmission in the world is said to be that of the Ox-Bow hydro-electric plant on the Snake river at Copperfield, Oregon. The installation consists of one 3600-kw., three-phase, 60-cycle generator, running at 225 r.p.m., operated by two water-wheel units. Each of these units consists of two pairs of water-wheels of the horizontal type, with 48-in. center discharge, set in open flume, and operating at 147 r.p.m., and 21 ft. head. The water is supplied through a tunnel cutting off a bend in the river. Each water-wheel unit is connected to the generator by four Morse chains 21 in. wide, with sprockets of 2-in. pitch on the line shafting, and with shaft centres 10 ft. apart. The generator shaft is in the centre and 5 ft. above the level of the water-wheel shafts. This chain drive is said to be three times greater in size than any previously built, the largest one previous to this being at Indianapolis, Ind., and driving a 1200 hp. generator. The Ox-Bow plant was designed originally to operate under a 45-ft. head obtained by a natural fall of 21 ft. by the tunnel through the bend in Snake river, and the building of a diversion dam across the river below the tunnel.—*Engineering News.*

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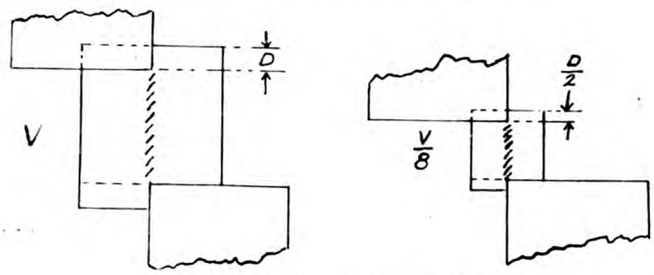
The Mechanical Efficiency of Crushing

By HERMAN C. KENNEY

Kick's law states that to produce similar alterations in the form of similar bodies requires work in proportion to the volumes of the bodies, according to my understanding of it. In an article by A. O. Gates[1] it is shown in his Fig. 1 how this law applies to cubes under stress. In Fig. 2 he has shown a cube subjected to shearing stress and has shown how the law is inapplicable in this case. It seems to me, however, that the law applies here also. Take the following figure:



100 Mesh Cube
Area one Section = A
Average resistance to shear per square inch = F
Energy = F A D
Energy Proportional to Volume.
200 Mesh Cube

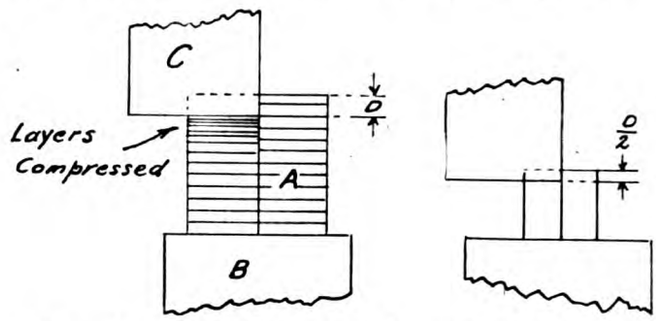
$$\text{Area one Section} = \frac{A}{4}$$

$$\text{Energy} = F\,\frac{A}{4}\,\frac{D}{2}$$

(In Mr. Gates' Fig. 2 he assumed that D and D/2 shown above were identical when fracture occurred.)

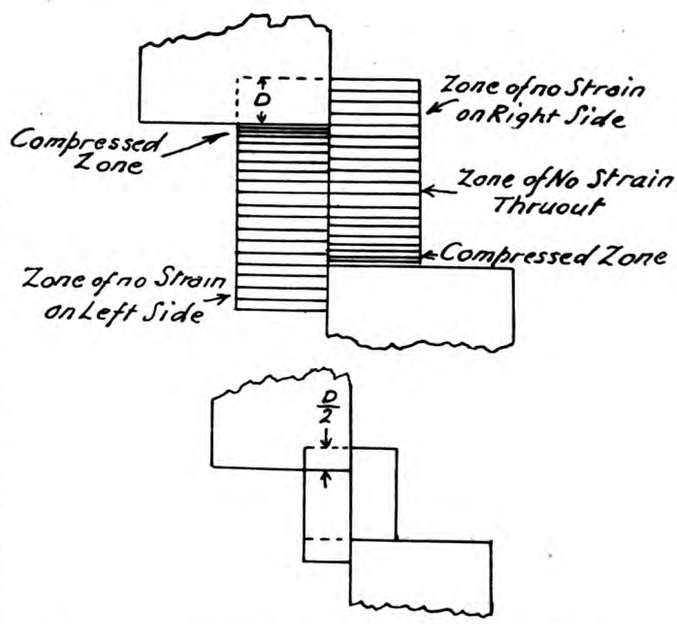
Here analogous changes of configuration have taken place and the work done is proportional to the volumes, as shown and as Kick's law states. This is assuming that the cubes have not been ruptured; that is, that they have not been strained beyond the elastic limit. This, it seems, is all Kick's law implies, as 'configuration' in itself signifies form or shape and not state of division, and the law is essentially a re-statement of the laws of elasticity. Make the assumption that any body is perfectly elastic to a certain degree, however slight, and that up to the elastic limit stress varies as strain. From this point to the yield point, at which the first visible break occurs, the stress is no longer proportional to the strain, and small latent breaks are occurring whose extent cannot be determined.

Now, does Kick's law hold beyond the elastic limit? In Mr. Gates' Fig. 2 it was assumed that the shearing distance would be the same irrespective of the diameter of the cube. That is, if cube V required the force to pass through distance D, cube V/8 would require the force to pass through this distance also, whereas to obey Kick's law D/2 would be required as shown. If the blocks were perfectly inelastic the former would, no doubt, be true, but consider the following case:



The cube A is supported on the anvil B, and C is a distorting force. The left side of A would be compressed, the upper layers more than the lower, and in time these would tend to separate from the upper layers of the right side. In a block of half the diameter the same relative effect would be produced by the force moving through half the distance as before, even though rupture may have taken place. In this case Kick's law seems to be in force even beyond the elastic limit.

Applying this form of reasoning to Mr. Gates' Fig. 2 we have



Compression takes place on each side owing to the elasticity of the block, and finally to break it the central portions must have slid past each other far enough to cause rupture, as stated by Mr. Gates in his article.

Obviously, the greater the diameter of the block, the greater would be the distance necessary to produce the same relative effect, and it can be shown that this distance will vary as the diameter of the cube and will not be a constant quantity as stated in the article re-

[1] *The Engineering and Mining Journal*, May 24, 1913, p. 1039.

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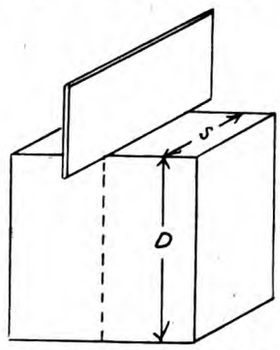
ferred to. So Kick's law seems to apply here also, and it seems as though it would apply beyond the elastic limit in all cases.

Take the simplest case of all. Suppose a soft chalky material that can be cut with a knife, and that a cube one inch on a side be taken for experiment. Then suppose the cube be cut into two equal parts. If the knife were sharp enough and strong enough, in short, a theoretical knife (since we are dealing in theories), that would sever the molecular bonds without causing compression or distortion, the work done can be expressed easily enough. The distance passed through must equal the diameter of the block, and the force must be the product of the length of the knife-blade in the cut, by the resistance offered to it per linear inch. In other words, the work would vary as the area of the cut.



F = Resistance per inch
Work = F D S

This work would be required if the cube were cracked or broken in the same place by any other means, as it is the net amount of work required to sever the bonds holding the halves of the block together.

Call the unit of work the force necessary to make a cut an inch wide acting through a distance of one inch, and equal to W. To cut a cube one inch on a side into eight equal cubes would require three cuts, or work equal to 3 W. If the original cube already had work expended on it equal to A, the total work in the eight small cubes would be 3 W + A, but since the surface of the original cube was six square inches, equal to fractures of three square inches, A = 3 W, the work in the eight cubes would be 6 W and each would have had work expended on it equal to $\frac{6\,W}{8}$ or ¾ W.

To tabulate:

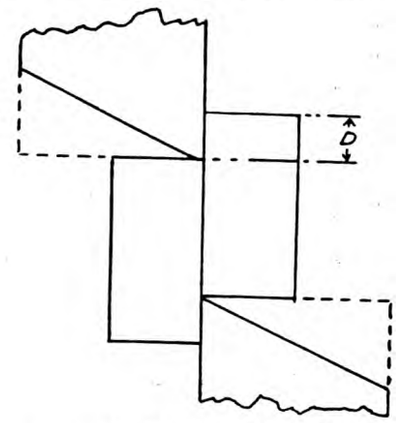
		Unit				
Side of cube, inches.	S	1	1/2	1/4	1/8	1/16
Number of pieces from unit	$P = \frac{1}{(s)^3}$	1	8	64	512	4096
Volume of each piece, cu. inches	$V = \frac{1}{P}$	1	1/8	1/64	1/512	1/4096
Number of unit cuts to reduce from unit cube		0	3	9	21	45
Total work	$\frac{S}{3W}$	*3W	*6W	12W	24W	48W
(For comparison....– 10 log 1/s †0		3	6	9	12)	

*See above.
†Proposed by C. A. Stadler.

So the series derived agrees with Rittinger's, and not Stadler's series. Rittinger's law states that the work of crushing is proportional to the surface exposed in crushing or to the reciprocal of the diameter crushed to.

There must be a loop-hole some place, and since I have previously shown that the distance the crushing force, or shearing force, passes through must be proportional to the diameter, there can be only two possibilities for the discrepancy in the two cases. Either (1) the force is not proportional to the surface of fracture, as claimed by Mr. Stadler, or (2) the area of application of the force is not equal to the area of the cube-face. Let us go back to Mr. Gates' Fig. 2.

Suppose the jaws of the shear were not square set, as assumed before, but beveled as shears usually are.



The force to cut the block could not have changed if, as given above, it is equal to the area of fracture, but the area of application of this force has changed from a surface to a line, and the work becomes

$$W = F\ D\ S \text{ for a one-inch cube}$$

$$\text{and } W = F\frac{D}{2}\frac{S}{2} \text{ for a cube } \tfrac{1}{2} \text{ in. on a side.}$$

This is not then a volume relation, but a surface relation, since F is constant, D varies as the diameter, and S equals the diameter. So W varies as S^2, as does the surface exposed in this operation. Of course it would be impossible, or nearly so, to shear a cube in this way, and this action might never occur in any commercial crushing operation. Theoretically, however, it is easy and it involves the use of an ideal machine when assuming a 100% efficient one. A steam-engine could never approach 100% thermal efficiency, and this may also be true of crushing devices.

To return to Kick's law. I have shown that it holds in all cases when the elastic limit has not been passed, just as it was intended to, but that in one case, at least, it does not apply thereafter. In my last figure it is evident that for every compression, however slight, there is a corresponding amount of fracture, and that there is added to the work of compression, which is proportional to the volume, the work of fracture in turn proportional to the surface of fracture. As the cut becomes nearly complete, the potential energy of compression changes to work of fracture and the work of compression is lost,

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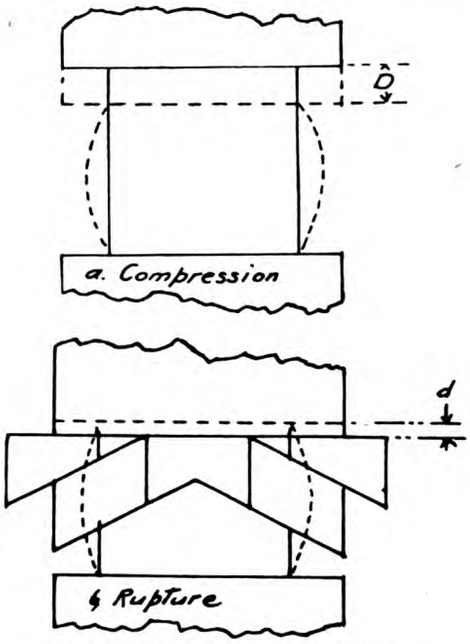
as such, and drops from both sides of the equation. In the case of straight compression, as in a testing machine or stamp, the work done divides into: (1) the work of compression, and (2) the work of fracture. The



PROCESS OF CRUSHING A CUBE.

work of compression will operate up to the yield point and is proportional to the volume, as Kick's law shows. The work of fracture is proportional to the surface of fracture, being simply the work to sever the molecular bonds, as I have shown in the case of cutting the cube where this work acts alone. Now at the yield point the work of compression changes to work of rupture and the parts tend to assume their original shape. To obtain 100% efficiency there should be a complete transfer of work of compression into work of rupture.

Then

$$\text{Work input} = W_c + W_f$$
$$\text{Work recovered} = W_c$$
$$\text{Total work} = W_c + W_f - W_c = W_f$$

But W_c varies as volume and W_f varies as surface exposed. If no further work is put into the rupture W_f must equal W_c, so surface exposed varies as volume.

Here is the agreement between the laws of Kick and Rittinger, showing how the work necessary to break cubes of the same material is at once proportional both to the volumes and the surface exposed by the break.

That the work required to rupture cubes of rock of various sizes is proportional to the volumes of the cubes has been shown by many tests. R. H. Richards in his 'Ore Dressing,' Volume I, page 300, gives the data for tests made at the Watertown arsenal in which it was demonstrated that the force to rupture cubes of the same material was a constant, independent of the size of the cube. From this it is easily shown that the work (= F A D) varies as the volume. No measurements of surface exposed were made in this case. Tests made at the same time on similar prisms showed that the work was a volume relation, but that it was not in any way related to the work to rupture a cube.

Rittinger's law in no way states that the work to rupture a cube is not proportional to the volume of the cube, neither does the law state that the work done is proportional to the diameter, or the square of the diameter, of the cube ruptured. The law states first of all that the work done is proportional to the surface exposed in the operation and that this surface is, to all intents and purposes, proportional to the reduction in diameter. It is difficult to understand what is implied by the word 'configuration' in the English version of Kick's law, but from the foregoing reasoning it seems that the law holds always within the elastic range and, in cases of straight compression, just up to the breaking point. Rittinger's law does not apply up to the elastic limit, since no surface is exposed. Between the elastic limit and the breaking point small breaks occur, but these cannot be measured; however, if the work is continued so that these breaks are developed they can be measured, so we must consider that the law is in force from the elastic limit on.

Mr. Stadler's version of Kick's law is that it applies always. He assumes that the work of compression in changing to work of fracture is sufficient, and just sufficient, to break the cube into eight similar cubes and that a like amount of work would break these eight into eight more each, yielding in each case surfaces proportional to the square of the diameter of the large cube. It is shown in Kent's handbook that suddenly applied forces are more destructive than slowly applied forces exerting the same amount of work. Kick's law explains this by saying that suddenly applied forces acting similarly will produce alterations in proportion to the volume, just as slowly applied ones do, but that for the same amount of work done the alterations need not be equal for equal cubes. Rittinger's law explains it by saying that when rupture occurs the surface of rupture is proportional to the work done in all cases. A rapidly applied force would require less work to rupture a block, and consequently would produce less surface. This is natural enough, for a sudden blow usually makes a cleaner break than a slow one. Mr. Stadler's theory is at a loss to explain this case, for he has made the assumption that a definite amount of force will divide a block into eight parts, regardless of the way it is applied.

Take the case of a prism. I have mentioned the Watertown Arsenal tests and how Kick's law applied for prisms as well as cubes. Rittinger's law, of course, does not consider the shape of the material, but applies in all cases. Stadler's theory, on the other hand, has nothing to do with prisms. Suppose a prism occurred in a lot of material to be crushed, I believe Mr. Stadler would divide it into eight parts as he does a cube with a unit expenditure of energy. Taking for comparison a prism 4 by 4 by 2 in. and a cube 4 by 4 by 4 in., they can be divided into eighths as shown in the figures on the next page.

According to Mr. Stadler, the force, and not the work, varies as the surface of fracture. In the case of the cube,

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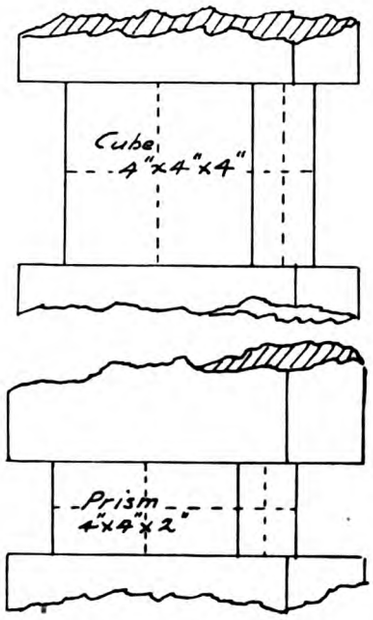
the surface exposed is 3 by 4 by 4 in. = 48 square inches. In the case of the prism the surface is (2 by 2 by 4) + 4 by 4 = 32 square inches. So the force to crush the cube would be greater than the force to crush the prism. The Watertown Arsenal tests showed just the opposite, the force to crush the cube being 5962 lb.,



and the force to crush the prism being 8028 pounds.

In case the unit cube does not break up into smaller cubes, Kick's law does not apply further, for the geometrical similarity has disappeared. Cutter (Richards' 'Ore Dressing,' Volume I, page 302) has shown that for blocks of nearly the same volume but slightly irregular in shape, the crushing force is not only not a constant but varied within wide limits, so that the work could not be proportional to the volume of the block. Mr. Richards explains this by the statement that in the cases where the force was greatest, the work done being also great, the blocks were shattered, while in the cases where it was least they were simply split, showing in this way the surface relation.

Referring again to Richards' 'Ore Dressing,' Volume I, page 305-310, tests made by Von Reytt on an ore consisting mainly of quartz, calcite, argentiferous galena, and blende, by crushing in various machines, show that the increase in surface per horse-power varied between 20 and 40 square metres. This was considering, of course, that the machines were 100% efficient. These limits in themselves are very reasonable and are not nearly as wide as the variation between Rittinger's law and Stadler's theory. He adds that in the finer sizes the increase in surface was greater than the law called for. This is very natural under the circumstances, since the ore was heterogeneous and the more easily broken constituents tend to accumulate in the fine. Then, too, if latent breaks had occurred these would tend to show more in the finer sizes. Mr. Richards sounds a warning note against assuming that all the constituents of an ore have the same specific gravity and tensile strength, citing the case of quartz and galena. He shows that the power to crush a given weight of quartz is to that to crush the same weight of galena as 15 is to 1.

Von Reytt, moreover, adds a table of results showing his energy calculations. This table, although not exactly according to Rittinger's law, is certainly far from being in accord with Stadler's theory. I hope that these observations may serve to show that Rittinger's law is not founded on fiction and should not be dropped as fallacious without direct experimental proof. Further argument without such proof seems to be but beating about the bush.

PURIFYING RESERVOIR WATER WITH COPPER SULPHATE

Interesting results have been achieved at the city of Gloucester, England, in dealing with the nuisance, in the city's reservoirs for the supply of potable water, caused by the growth of weeds which created an offensive odor and gave an objectionable color to the water. At one time it was necessary to reduce the growth of the weeds by the use of rakes—a process which involved considerable annual expense. As a consequence of experiments conducted by George Embrey, the analytical chemist for the Gloucester County council, the nuisance from the weed growth has now been effectually combated. It was found that the use of copper sulphate in quantities of 1 to 1,000,000 was eminently successful in destroying the lower forms of plant life without injuring the fish or rendering the water toxic to human beings. One of the methods of applying the copper sulphate is to place the crystals in a canvas bag and trail this at the stern of a moving boat. Another method is to scatter the fine crystals over the surface of the water as in sowing seed, the crystals falling rapidly to the bottom of the reservoir before dissolving. This has an advantage over the former process where the solution is much diluted before reaching the bottom.

The three reservoirs of the Gloucester corporation have a total capacity of 120,000,000 gallons, and the quantity of sulphate used is 400 pounds on each yearly application, or 1 to 3,000,000, which is found to be adequate to keep down the weeds. Each reservoir so treated is allowed to stand at least three days, and where possible a week, after the application, at the end of which period it is fit for domestic use and no trace of sulphur can be found in the water. The treatment, it has been found, is best carried out in the month of February.—*Canadian Engineer.*

A cement for making repairs on switchboards when iron or other metal has to be fastened to marble may be made from 30 parts plaster-of-paris, 10 parts iron filings, and ½ part of salammoniac. These are mixed with acetic acid to form a thin paste. This cement must always be used immediately after being mixed, as it solidifies rapidly.—*Mechanical World.*

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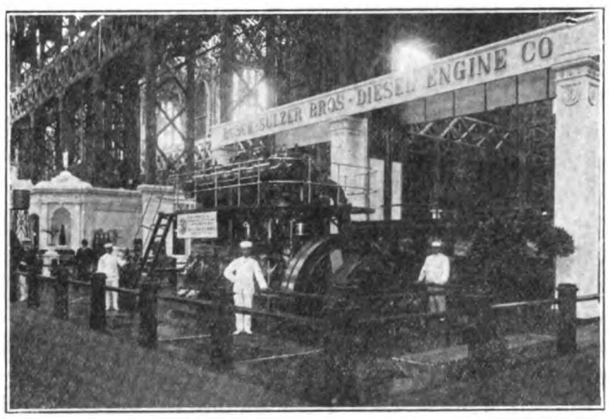
Industrial Progress

EXHIBIT OF BUSCH-SULZER BROS.-DIESEL ENGINE CO. AT P. P. I. E.

There are many working exhibits in the Palace of Machinery at the Panama-Pacific Exposition, and one of the most interesting is that of the Busch-Sulzer Bros.-Diesel Engine Co., of St. Louis, represented in San Francisco by W. S. Heger. Considerable expense and care has been taken in exhibiting this machine. It is known as the type 'B,' vertical, 4-cylinder, single-acting, 4-stroke cycle, enclosed crank case, medium-speed Diesel engine, with 3-stage air-compressor integral. In the factory at St. Louis only Diesel engines are manufactured, so that it is a specialty of the plant. The floor space occupied by this 500-hp. engine is 16 ft. 4 in. long, and 26 ft. 6 in. with alternating-current generator direct connected, 16 ft. high from floor to top of cylinders, and 10 ft. 8 in. wide. An inspection of the engine and claims by the makers reveal the following



500-HP. DIESEL ENGINE AT THE PANAMA-PACIFIC EXPOSITION.

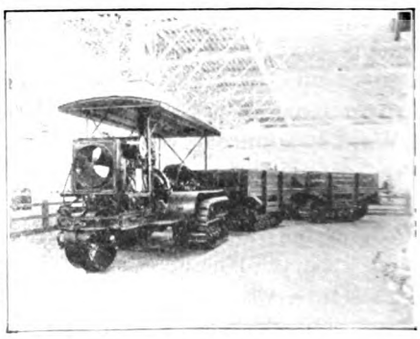
points: The machine, fitted with a 15-ton flywheel, is direct connected to a Westinghouse 335-kw., 250 volt, 1340-amp. generator, running at 200 r.p.m. The cycle of operation is as follows: cylinders charged with compressed air are used to start the engine. When in motion the down stroke draws in atmospheric air. The up stroke compresses this air to from 450 to 500-lb. pressure, during which time a temperature of 1000°F. is reached. At the top of this stroke, fuel oil of 23°B. is sprayed into the cylinder for 10 to 15% of the stroke, by air at 1000 lb., compressed by the 3-stage compressor which is part of the unit. The oil burns and the next stroke is the power stroke. The final part of the cycle is where the up stroke expels the gases produced. Oil consumption under operating conditions is 30 gal. per hour for the 500-hp. set. Below 50% load the proportion of oil used increases. The cost for fuel is 0.2c. per kw. hour. By heating to about 120°F., oil of 14° gravity can be used. The governing apparatus consists of a ring, which flies out when the speed is too high, and knocks a trip which cuts off the fuel. The governor runs on ball bearings. As to the fuel pump, the control of which is the chief duty of the governor, its function is to measure out and pump the fuel to the fuel valves. Two measured quantities of fuel are pumped by it to each fuel valve before each opening. For an engine operating at 200 r.p.m., with a power impulse each revolution, this means that the fuel delivered to the atomizers with each fuel pump discharge stroke, is the exact quantity necessary to care for the load for just one four-hundredths of a minute interval. All lubrication of the engine is done by a pump, and if the temperature of any bearing should rise, the pressure can be raised to 65 lb. Thermometers are placed at the oil inlet and outlet. Cam-shafts run in oil, and cams are so spaced as to leave no chance to move. Each cylinder being practically an engine in itself, makes repairs to valves an easy matter, and the whole engine works without trouble even if one cylinder is not giving power for a time. All cylinders are water-jacketed. Objections to the Diesel engine have included the carbonization of oil, air pockets in the cooling system caused by dead air or formation of steam, and the operator getting burned by exhaust pipes. These defects are claimed to have been successfully overcome by the Busch-Sulzer company. In the starting of this exhibit at the Exposition, on February 20, President Wilson in Washington closed a circuit there, which in turn closed the wireless key at Tuckerton. This sent the impulse to be caught by the antennae on the tower of jewels at the Exposition, the first time that the wireless had been used across the continent on power service. The impulse sent operated a galvanometer at the base of the tower, which in turn closed the local circuit that operated the electric release on a 500-hp. Diesel engine. This released a weighted lever which started the engine. This engine will be opened up every Monday from 9 a.m. to 5:30 p.m., to allow visiting engineers to inspect its working parts.

SMALL MAZDA LAMPS WITH CONCENTRATED FILAMENTS

The distinctive features of the concentrated filament Mazda lamps of high wattages have proved so popular that the Edison Lamp Works of the General Electric Co. has developed vacuum Mazda lamps of similar appearance in the 25, 40, and 60-watt sizes. This concentrated filament construction gives greater vertical distribution of light than the regular Mazda lamps of corresponding wattages. The new lamps will, therefore, be employed where natural distribution of light downward is required. They can be used in existing sockets and fixtures. These lamps will be made in the same sized bulbs as the corresponding regular Mazda lamps, will have the same spherical watts per candle-power efficiency, and will have a rated average life of 600 hours.

EXHIBIT OF HOLT MANUFACTURING CO. AT P. P. I. E.

The attractive and interesting exhibit of the Holt Manufacturing Co., of Stockton, California, occupies 15,000 sq. ft. of floor space in the Palace of Agriculture at the Panama-Pacific Exposition. Briefly, the display consists of an old English cottage in the centre, which serves as an office, and in the upper floor is a moving picture theatre showing Holt machines at work. Of most interest to engineers, across the aisle from the cottage are shown the Caterpillar '75' and the '45.' The former is an interesting study, being mounted so that the track revolves as in actual work. The motor is shown in full motion, with glass sides to the crank case, cylinders cut away to show pistons and rings, and a glass cover to the gear case. The 45-hp. Caterpillar, the type without a front wheel, is equipped with an electric motor and cable so that



75-HP. HOLT CATERPILLAR, TWO-SPEED, WITH 30-IN. TRACK AND TWO 10-TON TRAILERS.

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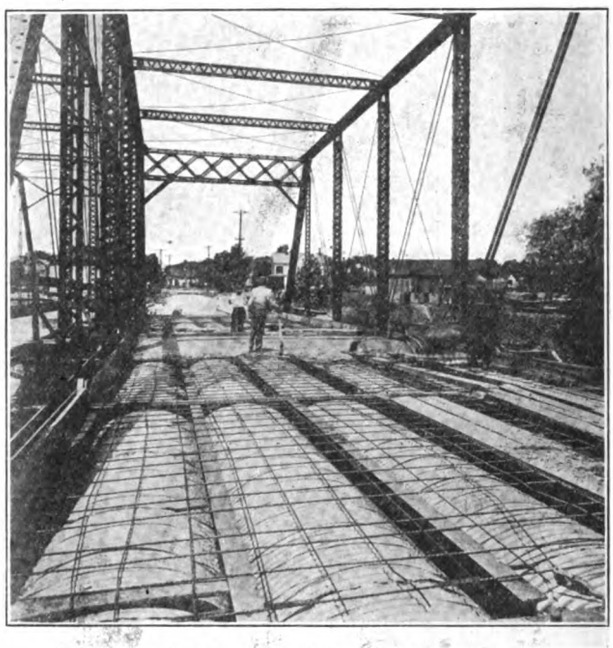
it actually moves about on its own tracks and demonstrates its short turning capacity. Another 75-hp. machine, with 30-in. tracks and military equipment, is shown with two 10-ton Caterpillar trailers. Several other exhibits more of interest to farmers are displayed, and the whole is an excellent arrangement showing the capabilities of this system of traction.

CORRUGATED IRON FOR BRIDGE FLOORING

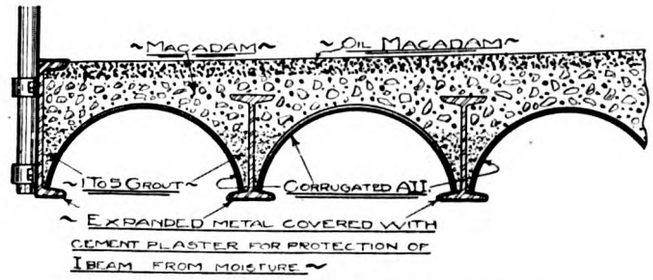
The use of corrugated-iron arches between the I-beams of modern steel bridges, as a form for concrete which constitutes the bridge-floor proper, is a somewhat familiar form of construction. The corrugated iron is often employed in very light gauges, and is not expected to bear any appreciable portion of the load. When the concrete is properly laid and properly reinforced, such bridge-floors are perfectly successful. A more recent development in the use of corrugated bridge flooring, and one that seems to have very decided advantages, consists in the employment of high-purity iron arches of sufficiently heavy gauge to withstand the load without much



PREPARING TO PLACE CONCRETE OVER ARCHES.

assistance from the pavement which covers them. Such arches do not require a covering of concrete. Asphalt or oil macadam may be employed, thus securing the advantage of a decidedly lessened dead load, which in turn enables the use of lighter I-beams and other supporting members. With the corrugated arches sufficiently heavy to carry the loads with a proper margin of safety, the pavement of the bridge may be of the same material as that of the adjoining streets or roads. This is a very decided advantage in many localities. One requisite of such a pavement, however, is that it allows the water to run off without penetrating to the I-beams and the corrugated arches. The high-purity iron is, of course, extremely resistant to corrosion, but the I-beams of structural steel are not, and even in the case of the galvanized arches the service-life will undoubtedly be still greater if moisture finds opportunity to attack them from the under side only. Some engineers have adopted the very excellent precaution of protecting the lower flange of the I-beams, which would otherwise be exposed, with expanded metal covered with cement plaster. The lower surface of the bridge is thus prepared to resist the action of the elements for very long periods.

A serious error which may easily be made in employing corrugated bridge flooring with a concrete covering is that of placing the dependence for load-carrying on the combined strength of the arches and the concrete. When neither by itself has sufficient strength to withstand the loads, the corrugated iron may yield or spring just enough to crack the concrete. Progressive destruction of the bridge-floor is then



SECTIONAL VIEW SHOWING FILLING OVER ARCHES.

only a matter of time and use. It is usually not difficult, however, so to plan the spacing of I-beams that the width of base of the corrugated arches will not be very great. With this dimension running from 24 to 36 inches, and with an allowable rise at the centre of the arch of 10 to 12 in., corrugated iron of the heavier gauges (No. 12 or in some cases No. 10) is amply sufficient for the work, and the pavement placed over it needs only to be of sufficient thickness properly to distribute the loads and sufficiently impervious to insure the run-off of the storm-water. The photograph shows the use of corrugated Armco iron on some large bridges in Ohio, where it seems to be giving excellent service. Quite a number of highway engineers in California have made very successful use of this construction.

THE HANNA WATER METER

The rapid growth of acreage of irrigated land, together with the consequent increased value of irrigating water, has brought with it a demand for greater accuracy in the methods of water measurement. To meet this demand, the Hess Flume Co., of Denver, Colorado, is manufacturing the Hanna water meter, which may be constructed for use in conjunction

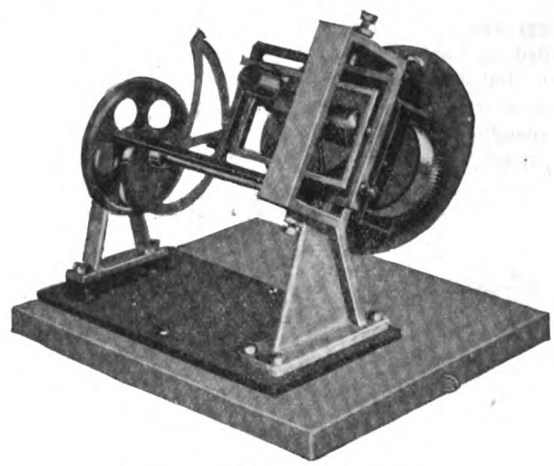


FIG. 1. HANNA WATER METER.

with open channels, weirs, or submerged orifices. A view of the meter is shown in Fig. 1 and the arrangement for using one in connection with either a Cippolletti or a rectangular weir is illustrated in Fig. 2.

The meter is made up of an eight-day clock, a spherical disk attached to and operated by the clock-shaft so that it rotates once each hour, a frame fastened to the clock, and

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the metal base supporting the meter. Within this frame and moving on a vertical axis is placed the arm-frame of the machine. The lower part of this frame is extended and forms the arm, operated by a cam, as will be described later. This frame, in turn, holds the small cylinder-frame parallel to the arm-frame and pivoted on a horizontal axis. The latter supports a cylindrical roll which rests against the spherical disk and whose axis of rotation passes approximately through that of the time-drive. A worm is cut on one end of the cylinder shaft and drives a counter which is fastened to the lower part of the cylinder frame. This counter records the number of revolutions of the roll. In the same horizontal plane as the moving arm and parallel to it when the roll is perpendicular to the centre line of the time-drive, and in a plane perpendicular to the centre line of the time-drive at

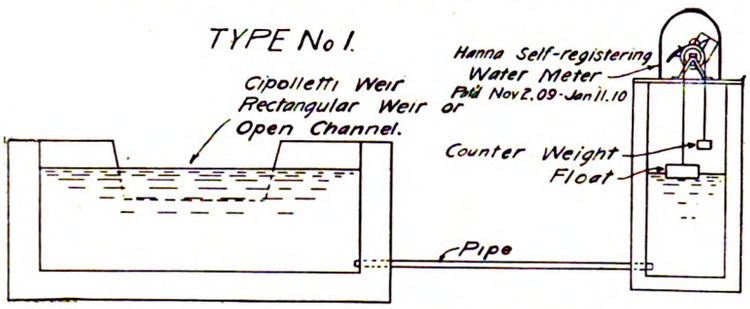


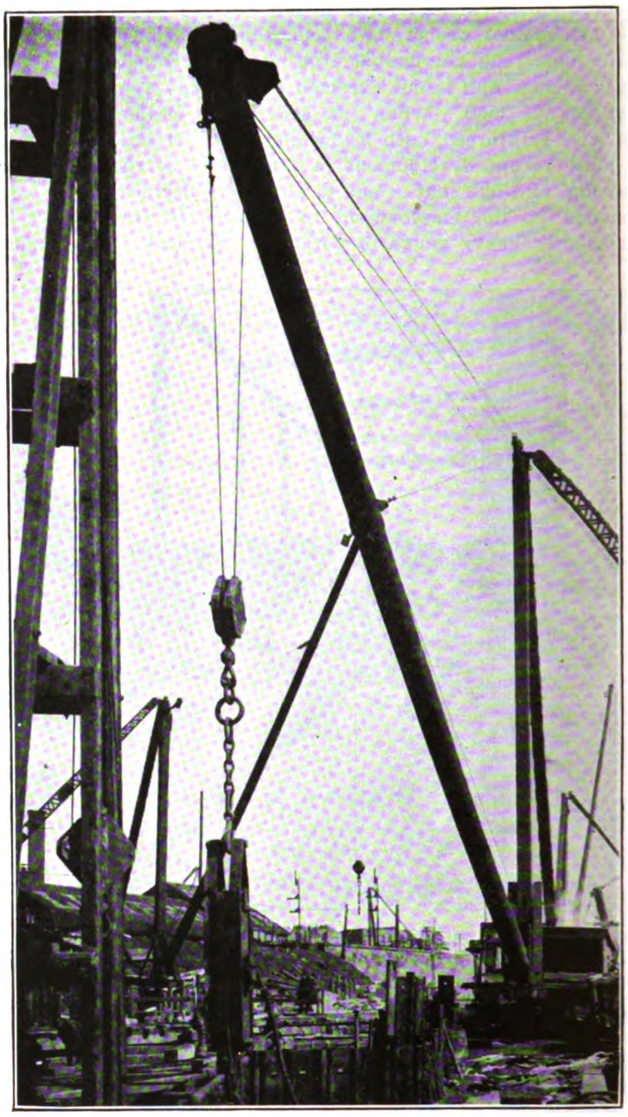
FIG. 2. ARRANGEMENT OF WEIR AND METER.

all times, is located a cam-shaft. The cam and float-wheel are mounted on and at right angles to this shaft. A tape or wire supporting the float passes over the float-wheel. A tape or wire carrying the counter-weight passes over the wheel of smaller diameter embodied in the float-wheel. The cam is mounted on the shaft so that when the water is level with the crest of the weir the reading on the cam will be zero and the arm in contact with it will be parallel to the cam-shaft and the cylinder will be tangent to the spherical disk at its centre of rotation, thus receiving no motion. As the water rises on the weir, the float rises a corresponding amount, and this motion is at once transmitted to the cam-shaft by the float-wheel. The cam thus moves around and pushes the roll-arm out so that the cylinder becomes tangent to the sphere at some point out from its centre of rotation. As the clock is turning the spherical disk at a uniform rate, the motion is transmitted to the roll and recorded on the counter. The cam of the machine is so designed that the record obtained on the counter is the discharge over the weir in acre-feet, or some factor thereof, corresponding to the length of the weir crest.

Hints on Practice

PULLING PILING WITH A STEAM-HAMMER INVERTED

One great drawback in the use of piling which is not required to be left in the ground has been the difficulty of removing it, and on many structures there has been a considerable money loss because it has been found impossible to remove the piling in such condition that it could be used again. A novel way of solving this difficulty by the use of an inverted steam-hammer was recently tried in New York, by N. R. Melvin, superintendent for McMullen & Hoff Co., of New York, who has applied for a patent on the device. A No. 5 McKiernan-Terry hammer was used. A 1½ by 4-in. steel strap was passed over the anvil-block down each side and projected about a foot below the bottom of the hammer in its inverted position. The lower ends of these straps were drilled to receive a pin which engaged a heavy pulling-shackle. Any convenient device can be used to connect the shackle with the pile to be pulled; a chain in the case of pulling round or square piles, or a shackle as shown in the illustration if pulling steel sheeting. Another pair of straps, ¾ by 4 in., were passed continuously around the hammer, one on each side of the strap previously described, and projected about 2 ft. above it, where they were connected by a heavy pin which received the pulling-chain of the derrick. When the lower end of the hammer has been connected to the sheeting, a strain is taken by the derrick, and steam or



HAMMER ARRANGED FOR REMOVING PILING.

air admitted to the hammer. The striking part, or piston, delivers upward blows to the anvil-block, which together with the strain of the derrick will pull piles or sheeting that it is practically impossible to pull otherwise.

As an instance of the effectiveness of this method, on one occasion the pulling-tackle without the hammer was hooked to a piece of sheeting. In spite of the fact that three derricks with an approximate combined pull of 25 tons were used, and that the sheeting was hammered sidewise with sledges, it could not be moved. The hammer and one derrick were then used and the sheeting was removed with ease. One great advantage of this method is that practically the same equipment that was used to drive the piles can be employed to pull them.

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Engineers' Note Book

TABLE OF MATERIALS REQUIRED FOR CONCRETE ROADS OF DIFFERENT WIDTHS

The following table, taken from the January *Record* of the Association of American Portland Cement Manufacturers, will be found useful in estimating on concrete-road projects.

TWO-COURSE PAVEMENT

WIDTH, 10 FEET.—BASE 4 INCHES AT SIDE AND 5¼ INCHES AT CENTER.—WEARING SURFACE 2 INCHES THICK THROUGHOUT.—AREA OF CROSS-SECTION—BASE, 0.447 SQ. YD.; TOP, 0.185 SQ. YD.—TOTAL, 0.632 SQ. YD.

Lin. Ft.	Superficial Area Sq. Yds.	Cu. Yd. Concrete Base	Base 1:2½:5			Base 1:2½:4			Base 1:2:4			Cu. Yd. Concrete Wearing Surface	Wearing Surface 1:2		
			Bbls. Cement	Cu. Yd. Sand	Cu. Yd. Stone	Bbls. Cement	Cu. Yd. Sand	Cu. Yd. Stone	Bbls. Cement	Cu. Yd. Sand	Cu. Yd. Stone		Bbls. Cement	Cu. Yd. Sand	Cu. Yd. Stone
1	1.11	0.149	0.18	0.07	0.14	0.21	0.08	0.12	0.22	0.07	0.13	0.062	0.223	0.026	0.039
25	27.78	3.72	4.61	1.71	3.42	5.17	1.90	3.05	5.62	1.67	3.31	1.55	5.57	0.66	0.99
30	33.33	4.47	5.54	2.06	4.11	6.21	2.28	3.67	6.75	2.01	3.98	1.86	6.68	0.79	1.19
35	38.89	5.22	6.47	2.40	4.80	7.26	2.66	4.28	7.88	2.35	4.65	2.17	7.80	0.92	1.38
5280	5867	787	976	362	724	1094	401	645	1188	354	700	326	1170	139	208

WIDTH, 10 FEET.—BASE 5 INCHES AT SIDE AND 6¼ INCHES AT CENTER.—WEARING SURFACE 2 INCHES THICK THROUGHOUT.—AREA OF CROSS-SECTION—BASE, 0.54 SQ. YD.; TOP, 0.185 SQ. YD.—TOTAL, 0.725 SQ. YD.

1	1.11	0.18	0.22	0.08	0.17	0.25	0.09	0.15	0.27	0.08	0.16	0.062	0.223	0.026	0.039
25	27.78	4.50	5.58	2.07	4.14	6.26	2.30	3.69	6.80	2.08	4.01	1.55	5.57	0.66	0.99
30	33.33	5.40	6.70	2.48	4.97	7.51	2.75	4.43	8.15	2.43	4.81	1.86	6.68	0.79	1.19
35	38.89	6.30	7.81	2.90	5.80	8.76	3.21	5.17	9.51	2.84	5.61	2.17	7.80	0.92	1.38
5280	5867	951	1179	437	875	1322	485	780	1436	428	846	326	1170	139	208

WIDTH, 12 FEET.—BASE 4 INCHES AT SIDE AND 5½ INCHES AT CENTER.—WEARING SURFACE 2 INCHES THICK THROUGHOUT.—AREA OF CROSS-SECTION—BASE, 0.555 SQ. YD.; TOP, 0.222 SQ. YD.—TOTAL, 0.778 SQ. YD.

1	1.33	0.185	0.23	0.09	0.17	0.26	0.09	0.15	0.28	0.08	0.16	0.074	0.266	0.031	0.047
25	33.33	4.62	5.73	2.13	4.25	6.42	2.36	3.79	6.98	2.08	4.11	1.85	6.65	0.79	1.18
30	40.00	5.55	6.88	2.55	5.11	7.71	2.83	4.55	8.38	2.50	4.94	2.22	7.97	0.94	1.42
35	46.67	6.48	8.04	2.98	5.97	9.00	3.30	5.31	9.78	2.92	5.77	2.59	9.30	1.10	1.66
5280	7040	977	1211	449	899	1358	498	801	1475	440	870	391	1403	166	250

WIDTH, 12 FEET.—BASE 5 INCHES AT SIDE AND 6½ INCHES AT CENTER.—WEARING SURFACE 2 INCHES THICK THROUGHOUT.—AREA OF CROSS-SECTION—BASE, 0.667 SQ. YD.; TOP, 0.222 SQ. YD.—TOTAL, 0.889 SQ. YD.

1	1.33	0.22	0.27	0.10	0.20	0.30	0.11	0.18	0.33	0.10	0.20	0.074	0.266	0.031	0.047
25	33.33	5.55	6.88	2.55	5.11	7.71	2.83	4.55	8.38	2.50	4.94	1.85	6.65	0.79	1.18
30	40.00	6.67	8.27	3.07	6.14	9.27	3.40	5.47	10.07	3.00	5.95	2.22	7.97	0.94	1.42
35	46.67	7.78	9.65	3.58	7.16	10.81	3.97	6.38	11.75	3.50	6.92	2.59	9.30	1.10	1.66
5280	7040	1173	1455	540	1079	1630	598	962	1771	528	1044	391	1403	166	250

WIDTH, 14 FEET.—BASE 4 INCHES AT SIDE AND 5¾ INCHES AT CENTER.—WEARING SURFACE 2 INCHES THICK THROUGHOUT.—AREA OF CROSS-SECTION—BASE, 0.669 SQ. YD.; TOP, 0.259 SQ. YD.—TOTAL, 0.928 SQ. YD.

Lin. Ft.	Superficial Area Sq. Yds.	Cu. Yd. Concrete Base	Base 1:2½:5			Base 1:2½:4			Base 1:2:4			Cu. Yd. Concrete Wearing Surface	Wearing Surface 1:2		
			Bbls. Cement	Cu. Yd. Sand	Cu. Yd. Stone	Bbls. Cement	Cu. Yd. Sand	Cu. Yd. Stone	Bbls. Cement	Cu. Yd. Sand	Cu. Yd. Stone		Bbls. Cement	Cu. Yd. Sand	Cu. Yd. Stone
1	1.55	0.22	0.27	0.10	0.20	0.30	0.11	0.18	0.33	0.10	0.20	0.086	0.309	0.036	0.055
25	38.89	5.57	6.91	2.56	5.12	7.74	2.84	4.57	8.41	2.51	4.96	2.15	7.72	0.91	1.37
30	46.67	6.69	8.30	3.08	6.15	9.30	3.41	5.49	10.10	3.01	5.95	2.59	9.26	1.10	1.65
35	54.44	7.80	9.67	3.59	7.18	10.84	3.98	6.40	11.78	3.51	6.94	3.01	10.81	1.28	1.92
5280	8213	1177	1459	541	1083	1636	600	965	1777	530	1048	456	1630	193	290

WIDTH, 14 FEET.—BASE 5 INCHES AT SIDE AND 6¾ INCHES AT CENTER.—WEARING SURFACE 2 INCHES THICK THROUGHOUT.—AREA OF CROSS-SECTION—BASE, 0.799 SQ. YD.; TOP, 0.259 SQ. YD.—TOTAL, 1.058 SQ. YDS.

1	1.55	0.26	0.32	0.12	0.24	0.36	0.13	0.21	0.39	0.12	0.23	0.086	0.309	0.036	0.055
25	38.89	6.67	8.27	3.07	6.14	9.27	3.40	5.47	10.07	3.00	5.94	2.15	7.72	0.91	1.37
30	46.67	7.99	9.91	3.68	7.35	11.11	4.07	6.55	12.06	3.60	7.11	2.59	9.26	1.10	1.65
35	54.44	9.33	11.57	4.29	8.58	12.97	4.76	7.65	14.09	4.20	8.30	3.01	10.81	1.28	1.92
5280	8213	1407	1745	647	1294	1956	718	1154	2125	633	1254	456	1630	193	290

WIDTH, 14 FEET.—BASE 4 INCHES AT SIDE AND 6 INCHES AT CENTER.—WEARING SURFACE 2 INCHES THICK THROUGHOUT.—AREA OF CROSS-SECTION—BASE, 0.691 SQ. YD.; TOP, 0.259 SQ. YD.—TOTAL, 0.950 SQ. YD.

1	1.55	0.230	0.29	0.11	0.21	0.32	0.12	0.19	0.35	0.10	0.20	0.086	0.309	0.036	0.055
25	38.89	5.75	7.13	2.65	5.29	7.99	2.93	4.72	8.68	2.59	5.12	2.15	7.72	0.91	1.37
30	46.67	6.91	8.57	3.18	6.36	9.60	3.52	5.67	10.43	3.11	6.15	2.59	9.26	1.10	1.65
35	54.44	8.05	9.98	3.70	7.41	11.19	4.11	6.60	12.16	3.62	7.16	3.01	10.81	1.28	1.92
5280	8213	1216	1508	559	1119	1690	620	997	1836	547	1082	456	1630	193	290

WIDTH, 14 FEET.—BASE 5 INCHES AT SIDE AND 7 INCHES AT CENTER.—WEARING SURFACE 2 INCHES THICK THROUGHOUT.—AREA OF CROSS-SECTION—BASE, 0.821 SQ. YD.; TOP, 0.259 SQ. YD.—TOTAL, 1.08 SQ. YDS.

1	1.55	0.274	0.34	0.13	0.25	0.38	0.14	0.22	0.41	0.12	0.24	0.086	0.309	0.036	0.055
25	38.89	6.84	8.48	3.15	6.29	9.51	3.49	5.61	10.33	3.08	6.09	2.15	7.72	0.91	1.37
30	46.67	8.21	10.18	3.78	7.55	11.41	4.19	6.73	12.40	3.69	7.31	2.59	9.26	1.10	1.65
35	54.44	9.58	11.88	4.41	8.81	13.32	4.89	7.86	14.47	4.31	8.53	3.01	10.81	1.28	1.92
5280	8213	1445	1792	665	1330	2009	737	1185	2182	650	1286	456	1630	193	290

WIDTH, 16 FEET.—BASE 4 INCHES AT SIDE AND 6 INCHES AT CENTER.—WEARING SURFACE 2 INCHES THICK THROUGHOUT.—AREA OF CROSS-SECTION—BASE, 0.791 SQ. YD.; TOP, 0.296 SQ. YD.—TOTAL, 1.087 SQ. YDS.

1	1.78	0.264	0.33	0.12	0.24	0.37	0.13	0.22	0.40	0.12	0.23	0.099	0.356	0.042	0.063
25	44.44	6.59	8.17	3.03	6.06	9.16	3.36	5.40	9.95	2.97	5.87	2.48	8.90	1.06	1.58
30	53.33	7.91	9.81	3.64	7.28	10.99	4.03	6.49	11.94	3.56	7.04	2.96	10.68	1.26	1.90
35	62.22	9.23	11.45	4.25	8.49	12.83	4.71	7.57	13.94	4.15	8.21	3.46	12.43	1.47	2.21
5280	9387	1392	1726	640	1281	1935	710	1141	2102	626	1239	523	1880	223	334

Book Reviews

CENTRIFUGAL PUMPS. By R. L. Daugherty. P. 187. Ill., index. McGraw-Hill Book Co., Inc., New York. For sale by the *Mining and Scientific Press*. Price, $2.

The introduction of the steam-turbine and the electric motor has reduced the cost of operation of centrifugal pumps and widened the field of their use. One result of this has been that the practical development of the centrifugal pump has outstripped the literature on the subject. The present volume will tend to remedy this condition. After describing the general features of centrifugal pumps, both of the turbine and volute type, the general theory of the entire subject is developed. Characteristic curves are then discussed, also the general question of pump efficiency. Two short chapters are devoted to a comparison of centrifugal and displacement pumps, and to a contrast between the various types of the former. The contents of the remainder of the book is best described by the chapter headings: Pump Testing, Costs, Rotary and Screw Pumps, Applications of Centrifugal Pumps, Design of a Centrifugal Pump. Problems are given at the end of most of the chapters and an appendix contains review questions. The book is well illustrated and there are a number of charts.

HEATING AND VENTILATING BUILDINGS. By Rolla C. Carpenter. P. 583. Ill., index. John Wiley & Sons, Inc., New York. For sale by the *Mining and Scientific Press*. Price, $3.50.

This is the sixth edition of a useful treatise. Few departments of engineering have more to do with the health and comfort of the general public than the heating and ventilation of buildings. The first five chapters deal with the theoretical basis for the consideration of the subject. Pipe and fittings used in heating systems are next discussed, and then radiators and heating surfaces. Following this, boilers and hot-water heaters are considered, space being devoted to the different types of boilers in use, together with their accessories and the methods of setting them. Next in order come steam-heating systems of both the gravity and the pump-return type. Then hot-water and hot-air systems are discussed. The subject of mechanical ventilators leads to that of hot-blast heating. A short chapter is devoted to electric heating, and one to thermostats and other temperature-regulating devices. A chapter is given to the heating and ventilating of special kinds of buildings, schools, factories, etc. Specifications and the general commercial aspects of the subject are then considered. The final chapter deals with the 'conditioning' of air, both for the removal of dust and for securing the correct proportion of humidity. The appendix contains a list of references and a number of tables, including the general mathematical tables to be found in most text-books as well as others especially valuable in heating and ventilating work.

HEAT ENGINEERING. By Arthur M. Greene. P. 453. Index. McGraw Hill Book Co., Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $4.

This is a text-book dealing with the many engineering subjects in the consideration of which heat is an important factor. The first takes up the fundamental questions of thermodynamics, including the behavior of gases under constant pressure and constant volume, and the Carnot cycle. The methods of determining the efficiencies of various heat engines is next considered. Then comes a chapter on heat transmission through both solid and other substances. The remainder of the book is mainly taken up with a discussion of the application of the principles already considered to different kinds of machinery, as will be seen from the following list of chapter-headings: Air Compressors; The Steam

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Engine; Multiple Expansion Engines; Steam Nozzles, Injectors, Steam Turbines; Condensers, Cooling Towers, and Evaporators; Internal-Combustion Engines and Combustion; Refrigeration. The text is well illustrated by charts and by drawings of different engines and other machines, and a complete list of the symbols used is included for the elucidation of the text.

PETROLEUM INDUSTRY OF CALIFORNIA. By R. P. McLaughlin, assisted by C. A. Waring. *Bulletin* 69 of the California State Mining Bureau. P. 519. Ill., index. California State Printing Office, Sacramento, 1914. For sale by State Mining Bureau, Ferry building, San Francisco. Price, $2.

This is an important book to those who are interested in one of the greatest industries in the state of California. The folio of maps that accompanies the report was published a month earlier than the book.

Given ample authority to ascertain and present facts of the business as well as the technical side of the oil deposits, and qualified by ample experience, the authors have presented a new idea in publications of this character. Of the newer points, first come extensive graphic diagrams of well-production records, classified by oilfields. These are intended to shed empirical light, as it were, on the important question of how much oil can reasonably be expected to be won from various areas. Since this problem is governed by the influence of a number of complex factors, such as water-encroachment, value of product, production costs, etc., data thereon are welcome. The discussions accompanying the diagrams are inconclusive as to what might safely be gathered from the evidence given. Data on the personal factors in the oil-production, refining, and marketing business in California are intelligently discussed. There are also given the results of some experimental work lately done to determine the evaporation losses in oil-containers; it clearly shows that there is good scope for further research work of similar character.

The treatment of the subject as a publication on a basic industry is excellent. It is known that to cover adequately any single branch would require a volume; judicious selection of subjects as well as material was therefore necessary. Refining of oils, concerning which few are intimately conversant, is passed. The uses and applications of crude oil and gas in commerce, of greatest importance on the Pacific coast, are treated at fair length. The geology of the main producing oilfields is covered by presenting the generalized results, by competent authority, of the more extended geological investigations in recent years, while that of prospective fields is covered efficiently mainly by the original work of the assistant author. On the side of oil-production, the branch that has suffered most from the lack of proper technical guidance, excellent data are given in a rational way on both well-drilling and pumping-costs; the application and cost of the various forms of power, steam, gas, electricity, to these steps in production are described adequately. The cost of pipe-line carriage of oil, as given, directs attention to the profits made in this line of the industry, where concerned with such production and long-lived fields as obtain in California. The menace of water-flooding of the oil measures in many of the fields is forcefully discussed. The self-interest of operators has not been strong enough in this late period of low-priced oil to fight water-encroachment effectively; with poorly constructed state statutes, and with no arm to lean upon from the Federal side, it is most opportune for the State Mining Bureau to stand out strongly for measures designed to arrest further damage from this ever-pressing evil.

The discussion on the price of oil, the goblin that forever casts shadows (whether good or evil) across the slumbers of the oil-producer, seems to lead to but one conclusion, apparently somewhat reluctantly expressed. In effect, it is, that unless some restriction is placed (by statute?) on indiscriminate drilling, at least during periods of flush production, there is not much chance for the price to rise to a level commensurate with the risk, or even to a level high enough to cover cost of production to the average producer. This condition applies with special force to the present situation in California where the large sellers, few in number, and equipped with millions of capital, are in command with larger production of much newly proved acreage of great potential yield, and as yet but slightly drilled.

The book treats of important and interesting phases of the industry, the facts concerning which are not always available to the public. Interspersed with the statements of facts are opinions bluntly and pointedly expressed, which add to the interest of the reader. It might be said that the financial end has not been as fully described as it could have been, particularly the dividends. The folio accompanying the book presents both geologic and field maps brought up to September 1914. The maps are comprehensive, on a good working scale, and are excellently done. The appearance of the publication at this period, when there is considerable legislation pending, both Federal and State, that may affect not only the character of the future development of the oilfields, but the policy of handling the lands, is both timely and important; this aside from its evident value to those concerned with producing and handling the product.—J. H. G. W.

ENGINEERING ECONOMICS. By J. C. L. Fish. P. 206. Index. McGraw-Hill Book Co., Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $2.

Engineering has been defined as 'the art of doing with one dollar what any fool can do with two,' yet strangely enough many engineers fail to appreciate the intimate connection between engineering and economics. Often this is due to the fact that they have received no training in the fundamental principles of the latter subject. The author begins at the foundation with simple interest, and continuing with compound interest comes to the subject of sinking funds. The different formulae for the computation of sinking funds are discussed. The questions of first cost and salvage value are taken up, and the various depreciation formulae are considered. The different elements of yearly cost of service are then analyzed, and estimating is briefly considered. The remainder of the book is mainly devoted to the application of the principles already laid down to the selection of a particular type of structure for certain conditions. Most of this discussion is by means of concrete examples, such as the selection of a wooden bridge *v.* a steel bridge for a given service. There are appendices containing interest and sinking fund tables, tables of standard rates of depreciation for various structures, and a bibliography of the most important books on this and allied subjects.

BOILER MANAGEMENT AND INSPECTION. By Joseph G. Branch. P. 62. Illustrated. The Branch Publishing Co., Chicago. For sale by *Mining and Scientific Press*, San Francisco. Price, $1.

The days when almost the only requirement for a fireman's position was ability to shovel coal rapidly into a furnace door, and when an engineer was required to know but little more, have happily passed. The present volume is one of a number that have been written to meet the demand for a book that will explain in non-technical language, the principles underlying boiler management to the man who is actually going to manage boilers. The book is divided into short lessons, with a number of practical questions following each lesson. Besides discussing the operation of boilers, the calculation of the stresses in each part of boiler is explained, and the question of safety valves is considered in detail. Some space is also devoted to methods of combating boiler scale.

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Construction News Summary

Condensed From Our Daily Construction News Service.

ARIZONA

BISBEE—Knights of Pythias will erect building to cost $75,000. James Kraigbaum is interested.

DOUGLAS—Contract for furnishing 25,000 lin. ft. of 4-in. water pipe has been awarded to Momsen-Dunnagan-Ryan Co., El Paso, Texas, for $9000.

GLOBE—Bids are being received by division superintendent J. W. Williams for erection of stonework for depot for Arizona Eastern railway.

PARKER—Interior Department has awarded contract for furnishing rock for Colorado river levee to E. F. Sanguinetti, Yuma.

PRESCOTT—Arizona Power Co. will make additions to its Fossil Creek plant costing $250,000, including four miles of steel flume, 3000 ft. of pressure pipe, a diversion dam, and a 440-ft. intake tunnel. R. S. Mason is chief engineer.

CALIFORNIA

ANDERSON—State department of engineering has approved plans for Anderson-Cottonwood irrigation district, and bond election will be called soon.

ARBUCKLE—Citizens are considering paving of several streets. D. S. Nelson is interested.

AUBURN—Contract for erection of grammar school building has been awarded to Geo. S. Hayes, San Jose, for $35,808.——Supervisors have adopted plans and specifications for bridge on State highway over Bear river.

AZUSA—Contract for most of the electrical fixtures for the new lighting system has been awarded to Pacific States Electric Co.; contract for transformers has been awarded to General Electric Co.; and contract for guy-wire to Pacific Wire Rope Co., 1840 East 15th street, Los Angeles.

BAKERSFIELD—Contract for construction of part of Wasco-Lost Hills road has been awarded Mackie & McLean, San Francisco, for $64,825.98.——Bids will be received until 10 a.m., May 5, by board of supervisors for grading and construction of culverts on Part of Bakersfield-Glenville road, 5.4 miles. P. H. Everett is highway engineer.——All bids for furnishing cement for road construction have been rejected and county highway commission has recommended that bids be re-advertised.——Contract for improving 8¼ miles of Bakersfield-McKittrick road has been awarded to Mesmer & Rice, Marsh-Strong building, Los Angeles, for $47,461.40.——Bids will be received until 11 a.m., May 10, by L. E. Chenoweth, superintendent of schools, for furnishing electric light fixtures for high-school building.——Contract for construction of nine miles of county highway from Tehachapi to Cameron has been awarded to Robert Sherer & Co., Pacific Electric building, Los Angeles, for $34,925.30. Contract for construction of nine miles of highway between Maricopa and Oil River has been awarded to Thompson Bros., Fresno, for $29,657.74.——C. J. Hurrie & Son, Stockton, will erect glass factory costing $35,000.

BENICIA—Contract for street improvements has been awarded to O'Brien Bros., San Francisco, for $9932.

CALIENTE—Kneen Contracting Co., Los Angeles, is making additions to mill and cyanide plant. A. T. Copley is local manager.

CALIPATRIA—Bonds for $40,000 for a grammar school building have been voted.

CALISTOGA—Contract for erection of bath-house at Calistoga Hot Springs has been awarded to Miller & Cassidy, Vallejo, for about $40,000.——J. H. May, Napa, and Bardwell & Dillerman, were low bidders on sewer system at $14,515 and $14,200 respectively.

CALLAHAN—Twenty-stamp mill will be erected at McKeen mine. James Doyle is manager.

CARUTHERS—Plans have been prepared by E. J. Kump, Fresno, for high-school building costing $30,000.

CHOWCHILLA—Contract for construction of railroad depot has been awarded to McIsaacs & Rodner.

COLUSA—Contract for 2440-ft. bridge across 'trough' at Prize has been awarded to Duncanson-Harrelson Co., Chronicle building, San Francisco, for $33,745. The same company was awarded contract for 35 short bridges for $28,988. Contract for bridge near Maxwell has been awarded to C. E. Cotton, 540 32nd street, Oakland, for $7840.

CORONADO—Contract for improvement of Glorietta boulevard has been awarded to J. Engebretsen, San Diego, for $41,004.

CUTLER—Contract for extension of Minkler & Southern Railway has been awarded to L. J. Smith Contracting Co., Kansas City, Missouri. Work includes about 60,000 cu. yd. earth excavation and 20,000 cu. yd. solid and loose rock.

DELANO—Bids will be received until 1:30 p.m., May 4, by E. E. Timmons, clerk of school board, for erection of six-room school building. Plans on file with J. M. Saffell, Bakersfield.

DOYLE—Preliminary organization of Southern Lassen irrigation district, comprising 167,560 acres, has been completed and petition for election will be presented at next meeting of board of supervisors.

EAST SAN DIEGO—G. R. Daley, San Diego, has been awarded contract for improving 6000 lin. ft. of Hugo avenue and cross streets for $48,168.87.——Contract for improving Fairmount avenue has been awarded to Gibson & Pierik.

EL CENTRO—All bids for construction of reinforced concrete bridge at Holtville have been rejected and work will be done by day labor under direction of supervisor L. F. Shaw.

EMERYVILLE—Board of Trustees has adopted plans and specifications for paving Powell street at an estimated cost of $12,000. Plans have also been adopted for paving 67th street with oil macadam. Town engineer R. S. Hawley is preparing plans for a storm-sewer on San Pablo avenue and on Adeline street. Estimated cost, $9500.

FAIRFIELD—Contract for construction of four concrete bridges on state highway has been awarded to Duncanson-Harrelson Co., Chronicle Bdg., San Francisco, for a total price of $6143.

FIREBAUGH—Board of trustees has decided to install five street lights.

FRESNO—Contract for improvements on Fresno, Blackstone, and Van Ness avenues has been awarded to Thompson Bros.——Contract for paving alley in Block 76 has been awarded to California Road & Street Improvement Co.——Contract for paving alley in Block 67 has been awarded to Worswick Street Paving Co.——Contract for construction of $70,000 building for F. M. Roessler has been awarded to Frank Rehorn.——Board of Health has recommended installation of water and sewer systems in Arlington Heights district.——Contract for construction of building at county hospital has been awarded to G. H. Walley for $12,590.——Contract for furnishing road oil to county has been awarded to Union Oil Co.——Contract for construction of reinforced-concrete garage for J. C. Phelan has been awarded to Trewhitt & Shields for $41,000.——San Joaquin Light & Power Co. will erect power-plant costing $75,000 at Merced Falls. A. G. Wishon is general manager.

GALT—Bonds for $17,000 for erection of school building have been voted.

GLENDALE—Contract for furnishing ornamental lighting standards has been awarded to Southern California Electric Co., 625 South Main street.——Contract for improving Pioneer drive has been awarded to F. R. Sinclair, 221 Sinclair avenue.

GRASS VALLEY—Trustees have ordered sidewalks laid on East Main street.

GRIDLEY—Board of trustees has passed resolutions of intention to have certain streets paved. John Felleman is city engineer.

HANFORD—All bids for bridge over Cross creek were considerably in excess of engineer's estimate of $5500 and were rejected. Board of supervisors will receive new bids until May 4. Bids may be made upon the bidder's own designs or upon the designs of county surveyor B. Duffield, but all designs are subject to approval of State Highway Commission.——Mausoleum costing $40,000 will be erected in Hanford cemetery.

HARRISON GULCH—Victor Power & Mining Co. will construct electric power-plant. R. D. Jackson is manager.

HERMOSA BEACH—Contract for improving several streets has been awarded to Modern Construction Co., 1006 Wright & Callender Bdg., Los Angeles, and for improving 25th street to Highway Construction Company.

HOLLISTER—Trustees have decided to pave Monterey street and 6th street. Estimated cost, $25,000.

HOLTVILLE—American Steel Pipe & Tank Co., Pacific Electric Bdg., Los Angeles, was low bidder for furnishing 16-gauge, 8-in. riveted steel pipe at 37½c. per lin. ft. Total bid, $1193.

HUNTINGTON BEACH—Contract for construction of outfall sewer, including 1200 ft. of 12-in. cast iron pipe, has been awarded to Holland Construction Co., 229 Granger Bdg., San Diego, for $11,900.——Contract for construction of sewer has been awarded to Joe Chutuk, 315 South Gless street, Los Angeles, for $1229.20.

HUNTINGTON PARK—Contract for improvement of Huntington avenue has been awarded to Los Angeles Paving Co., 407 H. W. Hellman Bdg., Los Angeles.

HYDE PARK—Bids will be received until 8 p.m., May 7, by L. Wilhelm, school clerk, for construction of buildings for grammar school.

LODI—Contract for enlarging Tokay theatre has been awarded to E. T. Wisner and A. H. Bull for $3506.15.

LONG BEACH—Contract for construction of sidewalks on several streets has been awarded to James L. Frazer.——Contract for improving American avenue has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., Los Ange-

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les, for $36,272.35——Contract for improving Dawson avenue has been awarded to K. F. Tuttle, San Bernardino.

LOS ANGELES—Bids will be received at office of U. S. Reclamation Service, Federal Bdg., until 2 p.m., May 4, for furnishing material and erecting riveted steel pipe for the Strawberry Valley Project, Utah. Particulars from the U. S. Reclamation Service, Los Angeles, Washington, D. C., or Provo, Utah.——Contract for furnishing creosoted piles for Fish Harbor work has been awarded to Wier & Jordan, Central Bdg., for $16,230.50.——Bids will be received until 2 p.m., May 12, at office of U. S. Reclamation Service, for furnishing needle-valve outlets for Roosevelt reservoir, Salt River project, Arizona.——Contract for improving Oakwood avenue has been awarded to Wattson & Spicer, Wright & Callender Bdg., for $7422.88.——Contract for improving Murchison street has been awarded to Bryant & Austin, 1650 Compton avenue, for $21,039.-16.——Contract for improving Magnolia avenue has been awarded to Ford & Stout, Bradbury Bdg., for $46,079.42.——Contract for construction of sewer in Russel avenue has been awarded to J. Cholovich at $7281.——Contract for construction of sewer in 49th street has been awarded to B. Wucetich, 619 Castelar street.——Contract for improving Arroyo Seco avenue has been awarded to E. A. Simmons, 3931 Pasadena avenue, for $2222.79.——Contract for improving Mariposa avenue has been awarded to California-Arizona Construction Co. at $8325.29.——John F. Blee, 509 Union League Bdg., is preparing plans for 5-story reinforced-concrete warehouse of Neptune Meter Co.——Contract for erection of Manchester Avenue school has been awarded to Willard-Brent Co., 1119 Baker-Detwiler Bdg., for $31,739.——Contract for erection of building for grammar school at Chatsworth has been awarded to Mann & Knox Construction Co., 610 Delta Bdg., for $24,565.——Contract for erection of Miramonte school has been awarded to M. N. Yesberg, 1650 Morton avenue, for $19,475.——Contract for erection of 4-story reinforced concrete warehouse for A. Wohlfarth has been awarded to Alta Planing Mill Co., 830 McGarry street, for $21,634.——California-Arizona Construction Co., Brockman Bdg., has been awarded contract for improving Western avenue for $62,561.97. Same company has been awarded contract for improving alley near 7th street for $1175.84.——Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., has been awarded contract for improving Catalina street for $18,532.43.——George L. Carroll, 3315 Modjeska avenue, has been awarded the following contracts: Macadamizing in road district No. 53 for $2665, macadamizing in road district No. 79 for $9373, macadamizing in road district No. 79 for $9373, macadamizing in road district No. 81 for $16,950.——Pacific Electric Co. will erect reinforced-concrete passenger station costing $4000.——Harron, Rickard & McCone, 164 North Los Angeles street, have been awarded contract for furnishing one 6-ton traveling crane for county at $1740.——City council is considering plans for two viaducts across railroad tracks and Los Angeles river, one at 7th street costing $310,000, and the other at 9th street costing $225,000.——Contract for paving on Figueroa street has been awarded to George H. Oswald, O. T. Johnson Bdg., for $151,833.05.——Contract for furnishing 1000 tons crushed rock to the city has been awarded to Pacific Rock & Gravel Co., Pacific Electric Bdg.——Contract for improvement of part of 22nd street has been awarded to California-Arizona Construction Co., Brockman Bdg., for $14,387.38.

MARTINEZ—Board of supervisors has approved plans for bridge across Old and Middle rivers, costing $120,000. Bridge will be built jointly by Contra Costa and San Joaquin counties.

MERCED—Contract for erection of reinforced-concrete bridge on state highway over Little Dead Man's creek has been awarded to Berliner & Taylor for $1100.

MODESTO—Board of directors of Modesto irrigation district will receive bids until 2 p.m., May 4, for construction of fill over Indian Hill gulch.——Contract for construction of Riarden and Salter fills has been awarded to Tibbitts Pacific Co., San Francisco, for $71,065.——Directors of Modesto irrigation district have authorized surveys for outlet to Brashear ditch.

NEVADA CITY—Contract for construction of stamp-mill for Plumbago mine has been awarded to Robert Hathaway.

NEWPORT BEACH—Contract for improving Adams, Alvarado, Coronado, and Fernando streets has been awarded to M. S. Cummings, 1302 West 22nd streets, Los Angeles, for $2696.63.

OAKDALE—Board of supervisors of San Francisco has agreed to expend $3500, and supervisors of Tuolumne county $1500, for improving Big Oak Flat toll road.——Contract for extensions to system of Oakdale irrigation district has been awarded to J. H. Clark, for $15,000.

OAKLAND—Oakland library board will erect reinforced concrete library costing $35,000 for Melrose branch.——Contract for repairs on Webster street has been awarded to Healy-Tibbetts Construction Co., Main and Market streets, San Francisco, for $500.——Contract for repairs to Bay Farm Island bridge has been awarded to Duncanson-Harrelson Co., Chronicle building, San Francisco.

PALO ALTO—Resolutions of intention have been passed and bids will be received until some time in May for the construction of 750,931 sq. ft. street paving, and 17,574 lin. ft. concrete curbing. J. F. Byxbee, Jr., is city engineer.

PARLIER—Riverbed Gas & Water Co. is receiving bids for construction of gas plant costing about $30,000.

PASADENA—Contract for paving and improving Worcester street has been awarded to Andrew Holloway, 16 South Raymond avenue, for $5819.52.——Contract for furnishing water pipe has been awarded to H. R. Boynton Co., 216 North Los Angeles street for $8991.71.——Contract for ornamental lighting system on South Lake avenue has been awarded to F. E. Newberry Electric Co., 724 South Olive street, at $6064.——W. A. McNally, 199 East Colorado street, has been awarded contract for electric conduits on El Molino avenue for $14,876, and on Terrace drive for $7890.——Contract for construction of cement sidewalks on Ritzman street has been awarded to Raldo Shirar.

PETALUMA—Contract for construction of school building has been awarded to Ward & Goodwin, 110 Jessie street, San Francisco, for $66,487.

PLACERVILLE—Western States Gas & Electric Co. will spend about $75,000 on enlarging capacity of American river flume, enlarging power-house, and installing 1500-kw. generator.——Contract for furnishing cement for Hangtown Creek bridge has been awarded to J. B. Blair Lumber Co., at $3.25 per barrel. Contract for furnishing steel reinforcing rods has been awarded to E. L. Soule Co., Rialto building, San Francisco, for $109.

POMONA—Contract for installation of ornamental lighting system has been awarded to Keystone Iron Works, 965 North Main street, Los Angeles, for $15,938.80.

PORTERSVILLE—City engineer I. H. Althouse is preparing plans for 20 additional blocks of street pavement.——A. R. Moore will erect theatre building costing $25,000.

REDDING—Pittsburgh-Mount Shasta Gold M. & M. Co. will erect plant costing $100,000 for treatment of its ore. Whether smelting, leaching, or flotation will be used has not been determined. T. V. Scott, Pittsburgh, Pennsylvania, is secretary.——County will build 18 bridges costing about $200,000 at various points on state highway during the year.

REDONDO BEACH—Contract for concrete pavement on Guadalupe avenue, Marguerita and Topaz streets, has been awarded to Bingham & Pendleton, 310 Summit avenue, Hermosa Beach, at 12½c. per square foot.

REEDLEY—Doak Gas Engine Co., 4th and Madison streets, Oakland, has been awarded contract for furnishing gas-engine and pump for city water works for $3850.——Trustees have decided to postpone paving streets in business district.

RIALTO—City trustees are contemplating extension of lighting system.

RICHMOND—John Nicholl Co. has awarded contract for construction of roadway to Moffett & Meade, Monadnock Bdg., San Francisco, for about $30,000.——Contract for construction of sewers in Bay View Park district has been awarded to Chambers & Heafey, Bacon Blk., Oakland, for $9726.08.——Council is receiving bids for bitulithic pavement on 10th street.——Contract for addition to Peres school has been awarded to J. S. Hannah, Williams Bdg., San Francisco, for $10,341.——Contract for addition to Fairmont school has been awarded to W. H. Ecker for $8425.25.

RIVERSIDE—Contract for construction of 8.85 miles of concrete highway from Elsinore to Murrietta has been awarded to the Connors Construction Co., Los Angeles, for $26,712.05.——Plans and specifications have been adopted for highway from Temecula to San Diego County line, about nine miles.——Contract for construction of 11.83 miles of concrete highway from Perris toward Hemet has been awarded to James M. Montgomery Co., Alhambra, at $32,695.97.

SACRAMENTO—Contract for construction of part of state highway from Davis to Yolo causeway, 5 miles, has been awarded to Palmer & McBride, 503 Market street, San Francisco, for $41,583. Engineer's estimate was $52,253.70. Materials furnished by state valued at $44,164.10.——Contract for construction of state highway in Orange county near Serra has been awarded to Brashear-Burns Co., Van Nuys Bdg., Los Angeles, for $31,632.70. Engineer's estimate was $36,175.90. Materials furnished by state valued at $3338.90.——State sanitary inspector Edward T. Ross has recommended to the State Board of Health that immediate changes be made in the water systems of Auburn, Roseville, Newcastle, and Rocklin.——Following contracts have been awarded on state highway work: From Wheatland to southern boundary Yuba county, to E. E. Roddan & Son, Wheatland, for $19,985.50; from Traver to northerly boundary Tulare county, to W. A. Kettleman & Son, Sanger, for $20,126; from Traver to Goshen, to W. A. Kettleman & Son, for $34,761; from Yolo by-pass to Sacramento river, to Joe Lawrence, Broderick, for $24,205.——Bids will be received until noon, May 18, by W. F. McClure, state engineer, Forum Bdg., for erection of model rural school at Chico. Plans may be obtained from State Department of Engineering, upon deposit of $10.——Contract for building roof over city docks

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on Front street has been awarded to John Silva for $3176.——Contract for construction of water system has been awarded to Schaw-Batcher Co., Sacramento, and 356 Market street, San Francisco, for about $750,000.——Legislative committee has reported in favor of submitting additional bond issue of $12,000,000 for state highways to voters.——State Highway Commission will soon call for bids for construction of portion of highway from Ross to Larkspur, about one mile, and also approach to bridge over Coyote creek, both in Marin county.——Contract for improvement of E street has been awarded to C. E. Hodson.——Contract for improvement of 30th street has been awarded to Clark & Henery Construction Company.

SAN BERNARDINO—Contract for furnishing 5500 ft. of 20-in. water pipe has been awarded to Western Pipe & Steel Co., 1758 North Broadway, Los Angeles.——Contract for furnishing 4700 ft. of 12-in. pipe has been awarded to Baker Iron Works, 986 North Broadway, Los Angeles.——Board of supervisors will start construction of road to Redlands by day labor. This is the first work to be started under the $1,750,000 bond issue voted last fall.——Contract for construction of 8-in. pipe sewer has been awarded to George M. Cooley Co. for $1298.——Anthony Beimer is preparing plans for addition to public library.

SAN DIEGO—Contract for paving 14th street has been awarded to California-Arizona Construction Co., Brockman Bdg., Los Angeles.——Contract for improving Columbia street has been awarded to M. D. Goodbody.——Contract for completion of Ocean Beach sewer system has been awarded to A. C. Hose for $49,380.——Contract for construction of cement curbs and sidewalks on 3rd street has been awarded to H. H. Hancock.——Contract for improvement of several streets has been awarded to C. L. Hyde Construction Co., Spreckels Bdg., for $11,993.17.——Contract for construction of septic tank at La Jolla has been awarded to G. R. Daley for $2979.55.——Contract for grading and other improvements on several streets has been awarded to W. N. Parker for $9753.92.——Contract for grading and curbing Vista place has been awarded to C. L. Hyde Construction Co. for $2008.48.——Harris, Cromwell & Aldrich have completed surveys for racetrack at Tia Juana, and construction will be started soon. W. E. Tobias is interested.

SAN FRANCISCO—Board of public works has ordered the following street work: Sewers on Lane street; curbs, sidewalks, and asphalt and basalt pavement on part of De Haro street; grading and construction of sewers on part of De Haro street; asphalt and basalt pavement on 18th street; curbs, asphalt pavement, sidewalks, catch-basins, and culverts on Hampshire street; asphalt pavement on Harris place; curbs, basalt gutters, and cobble pavement on Duncan street; grading on 17th street; grading, curbs, sidewalks, sewers, catch-basins, and asphalt pavement on Morse street; curbing and paving on 19th avenue, estimated cost $27,000; grading and curbing Quintara street, estimated cost $25,430; grading, curbing, and paving 26th street, estimated cost $19,200; grading 37th avenue, estimated cost $16,000.——Contract for excavation, concrete, and fireproofing for an 8-story Class A building for Pacific Gas & Electric Co. has been awarded to J. R. Cahill at $28,760.——Board of public works has been authorized to enter into contract for alterations to Third-street bridge, for installing of reinforcing and feeder cables for Municipal Railway, and for constructon of sidewalks on part of Chestnut street.——Contract for construction of reinforced-concrete buildings for Seattle Brewing & Malt Co. has been awarded to Sound Construction & Engineering Co., Hearst Bdg., for about $560,000.——Proposition to purchase system of Spring Valley Water Co. for $34,500,000 has been defeated at election.——Contract for construction of museum in Golden Gate park has been awarded to Farrell & Reed, 3rd and Mission streets, for $55,000.——Following street work has been ordered: Grading on Oakdale avenue; sidewalks on Lyon street; grading, concrete curbs, sidewalks, and broken-rock pavement on Riveria street; cement curbs, sidewalks, catch-basins, culverts, and asphalt pavement on Lawton street; grading on Noriega street; granite curbs, basalt and asphalt pavement on Missouri street.——City engineer M. M. O'Shaughnessy has completed plans for extending Portola drive from Stanford Heights to 24th street. Estimated cost, $40,000.——City engineer M. M. O'Shaughnessy has prepared plans for boulevard costing $56,000 between Presidio and Lincoln park. Construction will commence immediately.——Bids will be received until 2 p.m., May 21, at office of Lighthouse Inspector, for furnishing coal, gasoline, and distillate.——City engineer M. M. O'Shaughnessy has prepared plans for highway through Bernal cut from Randall street to San Jose avenue.

SAN JOSE—Following street work has been ordered under Vrooman Act: Grading, asphalt pavement on asphaltic concrete foundation, with brick catch-basins and drains for three blocks on 8th street; similar improvements together with concrete curbs and gutters for six blocks on St. John street; similar improvements together with concrete curbs for three blocks on 11th street. Plans on file with R. E. Walter, city clerk.——City council has ordered improvement of 3 blocks on 12th street with asphalt pavement on asphalt concrete base, together with brick catch-basins and drains. Work is to be done under Vrooman Act.——Bids will be received until 11 a.m., May 10, by board of supervisors, for construction of reinforced-concrete bridge over Los Gatos creek.——Contract for erection of building for Young Women's Christian Association has been awarded to Morrison Bros. for $66,300.

SANTA ANA—Hart & Ducey were low bidders at $12,391.38 for construction of Dyer, Fairview, Smeltzer, and Wintersburg roads.——Contract for construction of 2¼ miles of 18-ft. concrete pavement, near Stanton, has been awarded to George Wiegand, Lamanda Park.

SANTA BARBARA—Contract for construction of Bath-street reinforced-concrete bridge has been awarded to Boardman Construction Co. for $3896.——Board of supervisors has postponed action on the calling of road bond election until May, pending legal advice.——Contracts for improvement of Valerio street and of Emerson street have been awarded to Municipal Improvement Co., San Francisco, for $31,137.84 and $10,346.82, respectively.——Contract for construction of reinforced-concrete top over bridge at Ortega street has been awarded to Munoz & Munoz, Central Bdg., Los Angeles.——Bids will soon be received by F. F. Flournoy for laying three miles of concrete pavement on Eucalyptus Hill road.

SANTA CRUZ—All bids for erection of concrete Manual Arts building have been rejected and new bids will be called for. No change will be made in plans. Lowest bid was $10,777. W. H. Weeks, 75 Post street, San Francisco, is architect.——City engineer W. G. Thompson is preparing plans for concrete roadbed on Ocean View avenue.

SANTA MONICA—City engineer is preparing plans for about 9000 lin. ft. of bitulithic pavement on Ocean avenue.

SANTA ROSA—City clerk will receive bids until early in May for grading and paving Santa Rosa avenue.——Residents of Laguna region are considering formation of drainage district. A. B. Swain is interested.——Board of supervisors will receive bids until early in May for construction of Lambert bridge. M. P. Youker is county surveyor.

SAUSALITO—Contract for street improvements has been awarded to Clark & Henery Construction Co., Sacramento, for $44,100.

SONORA—Improvements will be made at Buckeye gravel mine including installation of pulverizing plant and other machinery. G. P. Kelley and G. L. Gary, Sierra Madre, are interested.——County surveyor R. Thom, is preparing plans for reinforced-concrete bridge over Big creek on Yosemite road.

STOCKTON—City engineer C. E. Compton is preparing plans for filling Miner channel and installing culvert in place of wooden bridge.——Contract for sanitary sewers in Sperry addition has been awarded to Schuyler & Edwards, Oakland, at $6543.10.——Contract for storm-sewers in northwestern part of city has been awarded to Schuyler & Edwards for $4340.95.——City council has adopted plans and specifications for sewers in northern addition. Estimated cost is $6601.35.——Bids will be received by Carl Walker, secretary French Camp school district, until 8 p.m., May 5, for erection of school building. Plans on file with Ralph P. Morrell, Odd Fellows Bdg.——Bids will be received until 10 a.m., May 8, by board of supervisors for improving C. A. Howard road for about 12 miles. Plans on file with county surveyor F. E. Quail.——Contract for curbs and gutters in city park has been awarded to A. B. Munson & Son for $1837.80.——Election will be held in June to vote on bond issue of $350,000 for construction of sewers.——County surveyor Quail is preparing plans for building new grade from Old river to Middle river, about 4½ miles.

SUSANVILLE—Election has been called for June 1 for the purpose of voting on bond issue of $100,000; $80,000 for a courthouse and $20,000 for a hospital. Thad McKay is county surveyor.——Erection of flour mill is being considered. Many Bros. are interested.

TEHACHAPI—Bonds for $8000 for municipal electric lighting plant have been voted.

TROPICO—Contract for improving Palmer avenue has been awarded to Peter L. Ferry, 526 West Acacia street.

TURLOCK—Bonds for $16,000 for park purposes have been voted. This action also insures construction of $10,000 depot for Southern Pacific Company.

VENICE—Contract for improving Trolleyway has been awarded to Braun, Bryant & Austin, Santa Monica.

VISALIA—Contract for reinforced-concrete bridge over Cameron creek has been awarded to E. G. Noble for $1300.——Contract for construction of road from Tulare to Tagus has been awarded to Higdon Transfer Co., Tulare.——Federal Government and Tulare county will share cost of road in Sequoia national park on which work is to be commenced immediately.

WASCO—California Natural Gas Co., Taft, will extend lines into this vicinity.

WATSONVILLE—Land-owners in this vicinity are consider-

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ing formation of flood-protection district. O. D. Stoesser is interested.

WILLOW CREEK—Federal Government will spend $65,000 on construction of wagon-roads in Trinity forest. Frank Graham is district ranger.

WINTERS—Pittsburgh-Des Moines Steel Co. was low bidder at $3700 for construction of 100,000-gal. steel water-tank.

WOODLAKE—Bonds for $40,000 for erection of high-school building have been voted.

WOODLAND—Board of education is receiving bids for construction of two school buildings costing $100,000 each. W. H. Weeks, 75 Post street, San Francisco, is architect.

YUBA CITY—Citizens are considering paving of main streets of town under Vrooman Act.

YUCAIPA—Redlands & Yucaipa Land Co. has awarded contracts for irrigation system as follows: Two deep-well pumps to Clarence F. Locke Pump Co. for $4654; one booster pump to H. R. Worthington, 220 East 2nd street, Los Angeles; steel riveted pipe-line, 11,400 ft. of 12-in. pipe, to Baker Iron Works, 912 North Broadway, for $9632.

IDAHO

AMERICAN FALLS—Bids will be received until May 7, by H. C. Wones, chairman of sewer committee, for construction of sanitary sewers. Work includes 14,600 lin. ft. of 8-in. vitrified pipe, 4300 lin. ft. of 12-in. vitrified pipe, 3000 ft. ¾-in. wrought iron pipe, 18 concrete manholes, and 30 flush-tanks.

BOISE—Directors of Black Canyon irrigation district are considering proposition to develop 15,000 hp. and sell to towns in vicinity. If power can be sold, entire irrigation system involving expenditure of $5,000,000 can be financed. C. L. Tallmadge, New York, is interested.

BURLEY—Bonds for $60,000 for high-school building have been voted.

KELLOGG—New mill will be erected at Matchless mine. Gus Smith is manager.——Council is considering construction of municipal water system costing $125,000.

LEWISTON—Council is considering expenditure of $10,000 on street work.

MOSCOW—City council has decided to pave Polk street.

POCATELLO—Salt Lake Hardware Co. will erect reinforced-concrete warehouse costing $40,000. Headlund, Kent & McSweeney are architects.——Fales-Houston Packing Co. will build $250,000 packing plant. R. S. McConnell is interested.

SANDPOINT—County surveyor Chaffins is preparing plans for bridge across Pend Oreille river at Priest river. Estimated cost, $20,000.——C. Peterson was low bidder for construction of road from Bonners Ferry to Eastport at $17,543.

TWIN FALLS—Idaho Power & Light Co. is making surveys for power-line to Contact, Nevada.

MONTANA

BILLINGS—Contract for concrete settling-basins has been awarded to Hanlon & Oakes, Sioux City, Iowa, for $71,790.——Contract for water-system extensions, including 6 miles of cast iron pipe, has been awarded to Gordon Taylor Co., of Denver, for $34,709 80.——Contract for filter equipment has been awarded to Pittsburgh Filter Mfg. Co., Pittsburgh, Pa.——Contract for pump and motor has been awarded to Hanlon & Oakes for $1950.——Billings Improvement Co. will erect brick and concrete building costing $15,000.

DILLON—Bannack Consolidated Gold Mining Co. will erect stamp-mill and make other improvements. John S. Cowan and Bert Bannard, Salt Lake City, are interested.

GLENDIVE—City engineer Hanford has recommended purchase of high-pressure pump with capacity of 850 gal. per minute.

GREAT FALLS—Contract for about 111,000 cu. yd. excavation for new buildings for Boston & Montana smelter has been awarded to Clifton & Applegate, Hutton Bdg., Spokane.——Contract for construction of a bridge across Swan river has been awarded to Minneapolis Bridge Co., Minneapolis, for $2610.

MALTA—Bids will be received until 2 p.m., May 12, at office of U. S. Reclamation Service, for about 95,000 cu. yd. canal excavation. Work is about 10 miles from Saco on the Great Northern railway. Particulars from U. S. Reclamation Service, Washington, D. C., Great Falls, or Malta.——Contract for erection of high-school building has been awarded to Montgomery Contracting Co., Chinook, for $23,357.

POLSON—Contract for about 110,000 cu. yd. of excavation on Pablo lateral has been awarded to A. L. Markhus for $16,750.

OREGON

ASTORIA—Contract for improvement of six blocks on Lexington avenue has been awarded to E. A. Gerding at $2960.

BAKER—Plans are being considered for installing gold dredge on Clark's creek. Emil Melzer is interested.——Eagle River Power Co. will construct auxiliary steam-plant. J. K. Romig is manager.

COQUILLE—Contract for river dredging from Bandon to Coquille has been awarded to Puget Sound Bridge & Dredging Co., Central Bdg., Seattle, at 18c. per cu. yd. if 100,000 cu. yd. is dredged per month, and 12c. per cu. yd. if 200,000 cu yd. is dredged per month.

ECHO—W. B. Hinkle is preparing plans for irrigation system for Teel district. Work will cost $891,000 and will include dam 105 ft. high, tunnel 12,000 ft. long, and much open-ditch work.

ENTERPRISE—Contract for construction of sewer system has been awarded to J. H. Child, La Grand, for $14,958.

EUGENE—Contract for concrete work on reservoir has been awarded to H. E. Doering, 568 Maple street, Portland, for $9245. Contract for excavation has been awarded to Eugene Woodyard Co. for $6758.

GRANTS PASS—Twohy Bros. Co., 219 East 60th street, Portland, has announced that arrangements to finance railroad to Crescent City, Cal., have been completed and that construction will soon be started. Road will be 91 miles long and cost about $5,000,000.——Bids will be received until May 6, by E. L. Coburn, county clerk, for construction of courthouse. Plans from county clerk upon deposit of $5. E. E. McClaren, Lumber Exchange Bdg., Portland, is architect.

MILTON—Bonds for $18,000 for school buildings have been voted.

PENDLETON—Contract for construction of a steel bridge has been awarded to Illinois Steel & Bridge Co., Selling Bdg., Portland, for $8998.——Contract for construction of 11 other steel bridges has been awarded to Security Bridge Co., Spokane, Washington.

PORTLAND—Contract for vitrified-brick pavement on part of Russell street has been awarded to John Keating for $8371.——Contract for vitrified-pipe sewer on Stephens and East Clay street has been awarded to Azar & Co., 324 East 59th street, for $4491.——Bonds for $1,250,000 for hard-surface roads have been voted in Multnomah county.——Bids will be received until 5 p.m., May 5, by R. H. Thomas, school clerk, 401 Courthouse, for furnishing machinery and other equipment for Ockley Green manual training shop.——Council is considering paving part of East Alder street with basalt blocks on 6-in. concrete foundation. Estimated cost, including concrete sidewalks and curbs, is $18,201.——Contract for construction of piers on interstate bridge has been sublet to Portland Bridge & Building Co., Worcester Bdg.——Contract for construction of building for Libby, McNeill & Libby at The Dalles has been awarded to F. J. Leonard, Lewis Bdg., for $60,000.——L. P. Hobart, Crocker Bdg., San Francisco, is preparing plans for post-office building, costing $1,000,000.——City will erect auditorium costing $535,000.——Portland Railway, Light & Power Co. is considering building 18 miles of railroad from Cottrell to Sandy.

ROSEBURG—City council has called election for June 4 to vote on bond issue of $500,000. If these bonds are voted, Kendall Bros. and the city will construct railroad to Cascade forest reserve, and Kendall Bros. will erect sawmill. Total expenditure will be about $1,250,000.

ST. JOHNS—Contract for building two barges for work on Coquille river has been awarded to St. Johns Shipbuilding Co. for $7745.

SUMPTER—Powder River Gold Dredging Co. will purchase another dredge.

TILLAMOOK—Road costing about $10,000 will be constructed at Bayocean.

VALE—Contract for construction of bridge over Snake river has been awarded to Coast Bridge Co., Railway Exchange Bdg., Portland, for $23,000. Bridge will be of steel with concrete abutments and piers.

WARRENTON—Bonds for $25,000 for school building have been voted.

UTAH

DUCHESNE—Franchise for electric-light plant has been awarded to John Glenn, of Vernal, and Marcellus Pope and R. W. Kroupa. Estimated cost, $10,000.

NEPHI—Nephi Plaster & Manufacturing Co. will make additions to plant costing $15,000.

OGDEN—Contract for furnishing wood-stave pipe has been awarded to Portland Wood Pipe Co., Portland, Oregon, for $18,080.——Contract for furnishing Matheson lock-joint pipe has been awarded to George A. Lowe & Co. for $49,050.38.——Contract for laying all pipe has been awarded to Green Construction Co., Tooele, for $23,117.40.——Bonds for $150,000 have been sold by Davis & Weber Counties Canal Co., and construction of large dam will soon be undertaken. J. S. Nye is secretary.——Part of 24th street will be paved with Tarvia. One-half cost will be met by Barrett Manufacturing Co., Salt Lake City, which wishes to have demonstration of that kind

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of pavement.——Utah Construction Co. has been awarded contract for construction of 5-mile section of Idlewild-Huntsville extension of Ogden, Logan & Idaho railway.——City engineer W. Jenkins is preparing plans for paving Jackson avenue.

PARK CITY—Bids will be received until 3 p.m., May 13, by Supervising Architect, Treasury Department, Washington, D. C., for construction of post-office. Plans from Supervising Architect, Washington, D. C., or from custodian of site, Park City.

PAYSON CITY—Contract for construction of lateral 30 on Strawberry Valley project has been awarded to Wahsatch Grading Co., 312 Dooly Blk., Salt Lake City, at $47,083.62.

PROVO—Bids will be received until 2 p.m., May 19, at office of U. S. Reclamation Service, for construction involving 30,000 cu. yd. canal excavation, and 3400 cu. yd. reinforced concrete. Work is near Payson City, on the San Pedro, Los Angeles & Salt Lake railroad, and the Tintic branch of the Denver & Rio Grande railroad. Particulars from U. S. Reclamation Service, Washington, D. C., or Provo.

SALT LAKE CITY—City engineer S. Q. Cannon is preparing plans for $300,000 outlet sewer.——Deseret National Bank will erect 24-story building costing $1,000,000. Parkinson & Bergstrom, Security Bdg., Los Angeles, are architects.——Contract for construction of gateway at city cemetery has been awarded to Utah Consolidated Stone Co. for $2849.20.——Electric Bond & Share Co., New York, is planning merger of the most important hydro-electric corporations in Utah, Idaho, Colorado, and possibly Montana and Washington.——Citizens are considering ornamental lighting system in business district. George Romney is interested.——City council is considering purchase of asphalt-cutting machine. Richard P. Morris is commissioner of streets.——City commission has authorized expenditure of about $78,000 on street paving and water-works extensions.

WASHINGTON

BELLINGHAM—Contract for paving 5 miles of Guide Meridian road has been awarded to P. J. McHugh Contracting & Paving Co., Third and Mercer streets, Seattle.——Contract for asphalt paving on Monroe-street bridge has been awarded to Independent Asphalt Paving Co., Northern Bank Bdg., Seattle, for $18,000.——Contract for improvement of Chestnut street has been awarded to J. Lich at $2535.——Peter Zobrist will erect reinforced-concrete building costing $15,000.

BREMERTON—Contract for construction of gas plant costing $100,000 has been awarded to Burnett Construction Co., 909 Second avenue, Seattle.

CENTRALIA—Citizens here and at Chehalis are considering plans for dredging Chehalis river to provide navigable channel to Grays Harbor. W. D. Lyman, Walla Walla, is interested. ——Contract for construction of pasteurizing plant for Purity Milk Products Refrigerating Co. has been awarded to M. E. Greenleaf.

COLFAX—Bids will be received until about May 15 by state highway commission at Olympia for construction of four miles of highway from Cashup to Steptoe.——County commissioners will receive bids until May 17 for the construction of the Andy Horton road.

CONCRETE—Bids will be received until May 11 by C. F. Ramsdell, city clerk, for construction of concrete pavement on West Main street. Plans for city clerk upon deposit of $5.

EPHRATA—F. P. Gover has purchased city water system and will make additions.——Contract for construction of permanent highway 5A has been awarded to Mohr Construction Co., Waterville, for $4890.

EVERETT—Contract for construction of 255-ft. trestle over Allen creek has been awarded to Everett Construction Co. for $1269.90.——Contract for construction of Beverly Park highway has been awarded to Atlas Construction Co. for $13,716.——Contract for construction of Marysville viaduct has been awarded to Ward & Templeton for $1890.——Contract for construction of steel and concrete bridge near Lowell has been awarded to H. S. Wright, 2112 Tucker avenue, for $3873.——Contract for construction of permanent highway No. 2 has been awarded to Reinseth Bros., Arlington, for $8340.65.

GOSHEN—Contract for construction of 12-mile extension of Chicago, Milwaukee & St. Paul railway to Welcome has been awarded to Twohy Bros., 219 East 60th street, Portland, for $375,000.

HOQUIAM—Contract for repair of 8th-street bridge has been awarded to McCray & Willard, Spokane, for $7567.

KELSO—Engineers for state highway commission are making surveys for road to Willapa bay.

MONTESANO—Contract for construction of gas plant costing $50,000 has been awarded to Burnett Construction Co., 909 Second avenue, Seattle.

MT. VERNON—Contract for construction of LaConnor bridge has been assigned by Illinois Steel Co. to Skagit Construction Co.——Bids will be received until May 4 by W. V. Alexander, county auditor, for construction of John Grip road. A. L. Strong is county engineer.——Plans are being prepared for two miles of concrete pavement on permanent highway 2A, and for grading 2½ miles on McMurray road.

PALOUSE—County commissioners will build road from city limits to Idaho line, about 1½ miles, costing $3500.

PORT ORCHARD—Contract for construction of bridge near Silverdale has been awarded to Schold & Boughton, Silverdale, for $1222.40.——Contract for Colby bridge has been awarded to Jarvis & Garvey, 5206 15th street, Seattle.

SEATTLE—Plans are being prepared by city engineer A. H. Dimock for 900,000 cu. yd. fill at Oxbow on Duwamish river. ——Contract for improvement of 6th avenue has been awarded to Cresman & Doolittle, 605 First avenue, at $4323.——Contract for construction of Renton-Issaquah road has been awarded to Henry Brice, 4234 Densmore street, for $63,445.99.——Contract for paving Buckley bridge has been awarded to Independent Asphalt Paving Co., Northern Bank Bdg., for $3403.40. ——Contract for concrete sidewalks on North 76th street has been awarded to Baisden Bros., 544 First avenue, for $1854.25. ——Contract for grading and other improvements on 44th avenue has been awarded to Quigg Construction Co., Inc., L. C. Smith Bdg., for $21,396.——Contract for paving Ewing street has been awarded to R. G. Stevenson, 1327 Ewing street, for $20,562.75.——Contract for paving East Mercer street has been awarded to F. McLellan, Globe Bdg., for $34,067.70.——Bids will be received until 11 a.m., June 7, by county commissioners, for installing electric lighting fixtures in new courthouse. Specifications may be obtained from county commissioners upon deposit of $5. Bidders will submit their own designs.——Contract for construction of Duwamish fill No. 3 has been awarded to Holt & Jeffery, Railway Exchange Bdg., for $26,976.——Contract for grading and other improvements on 12th avenue has been awarded to McGuire Bros., 523 First avenue, for $6573.——Contract for grading and other improvements on 45th avenue has been awarded to Colasurdo & Co., 1318 20th avenue, for $38,959.35.——Plans are being prepared by B. M. Pretica, Empire Bdg., for $500,000 office and theatre building for Coloseum Company.——J. Q. Clemer, 1412 Second avenue, will erect $1,000,000 office and theatre building.——Contract for sprinkler system for Smith's Cove warehouse has been awarded to Rockwood Sprinkler Co., 208 Columbia street, for $6495.——City council has decided to ask for bids for Lake Washington Canal bridges on basis of plans of city engineering department alone, and not to allow bridge companies to submit their own plans.——Stephen & Stephen, New York Blk., are preparing plans for high-school building at Mt. Vernon, costing about $60,000.——Contract for furnishing ship conveyors for port commission has been awarded to Brinkley Supply Co., 524 First avenue south, for $10,480.——Contract for construction of power-plant for Lake Washington canal has been awarded to R. D. Wood & Co., Philadelphia, for $31,776.——City council is considering plans for additions to municipal steam-power plant at Lake Union.——Contract for construction of concrete snowsheds on Great Northern railway between Tye and Embyro has been awarded to Henry & McFee, White Bdg., for $250,000.——Henry Brice, 4234 Densmore street, will let subcontracts for work on Renton-Issaquah road.

SOUTH BEND—Bids for construction of permanent highway No. 1A under five different proposals have been opened. M. D. Hogan, Hoquiam, is low bidder on all proposals at prices ranging from $19,960 to $29,000. Award of contract is held up pending decision of Supreme Court on emergency clause.——Contract for diking system for district No. 2 has been awarded to Cowlitz Bridge Co., Yeon Bdg., Portland, for $60,000.

SPOKANE—Sub-contract for concrete lining for 5-mile tunnel at Rogers Pass, British Columbia, has been awarded to Bates & Rogers Construction Co., Lindelle Bdg.——Contract for concrete work at stock-yards has been awarded to C. M. Payne, 724 Mission street.——Contract for construction of 7-story Class A building on site of Mohawk block has been awarded to Sound Construction & Engineering Co., Lowman Bdg., Seattle, for $150,000.——Water superintendent A. Lindsay has recommended installation of 53 hydrants, costing $13,528.

TACOMA—Contract for sewers in East D street and South 31st street has been awarded to Pacific Sewer & Watermain Co. for $10,744.——Contract for paving Puyallup avenue has been awarded to McHugh Contracting Co., Provident Bdg., for $2100.

WALLA WALLA—County commissioners will receive bids until May 5 for construction of courthouse costing $150,000. ——Oregon-Washington Railway & Navigation Co. will erect roundhouse costing $60,000.——City commissioners have decided in favor of paving North Second street.

WENATCHEE—Construction of railroad to Holden mine, 26 miles long and costing about $500,000, is being considered. J. P. Graves, Old National Bank Bdg., is interested.

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Personal

C. D. SHAUVER has been appointed assistant state engineer of Wyoming.

E. M. CAPPS, former city and harbor engineer of San Diego, has been elected mayor.

L. B. WICKERSHAM has opened offices as a consulting engineer at 23 Ainsworth building, Portland.

L. H. BRADY has been appointed city engineer of San Bernardino, succeeding FRANK A. SMITH, resigned.

E. I. CANTINE, of Portland, has been appointed state highway engineer of Oregon, succeeding H. L. BOWLBY, resigned.

C. W. ANDERSON has been appointed city engineer of Centralia, Washington, succeeding STANLEY MACOMBER, resigned.

ROBERT L. READING, formerly county surveyor of Shasta county, has been appointed city engineer of Redding, California.

ROBERT F. HALL has been appointed publicity manager for the Universal Portland Cement Co., succeeding J. P. BECK, resigned.

WILLIAM OGDEN has resigned his position with Edward R. Bacon Co. to become factory representative for the Troy Wagon Works, of Troy, Ohio.

HOWARD W. HOLMES, formerly connected with the office of the city engineer of Portland, has been appointed assistant state highway engineer of Oregon.

W. J. ELMENDORF, formerly manager for the Portland Canal Terminals, Ltd., of Stewart, B. C., has opened offices as a mining engineer at 1027 Smith Building, Seattle.

ROBERT G. DIECK, commissioner of public works for the city of Portland, discussed the work of his department before the Oregon Society of Engineers at a recent meeting.

OLAF LAURGAARD, chief engineer for the Tumalo, Oregon, irrigation project until its completion, has opened an office as consulting engineer at 410 Railway Exchange building, Portland.

LEEDS & BARNARD, consulting engineers, Los Angeles, have been retained by the city of Venice to report on storm damage to the water front of the city and methods of protection from further damage.

S. F. B. MORSE, who has been manager for the Crocker-Huffman Land & Water Co. at Merced, California, has resigned to become general manager for the Pacific Improvement Co., with headquarters at San Francisco.

At the regular meeting of the San Francisco Association of Members of the American Society of Civil Engineers held at the Palace Hotel, April 16, H. H. HALL read a paper on 'Water Supply for Klondike Hydraulic Mines.'

The following reviewing board has been chosen to pass upon the expenditures on the Klamath irrigation project: W. H. SANDERS, for the Reclamation Service; ABEL ADY, for the water users; and J. P. NEWELL, third member.

E. D. VINCENT, assistant harbor engineer for the city of Los Angeles, has resigned. It is reported that no successor will be appointed, the work in his department being taken over by S. A. JUBB, chief harbor engineer.

At the annual meeting of the Utah Society of Engineers, the following officers were elected for the ensuing year: president, S. S. ARENTZ; first vice-president, R. S. LEWIS; second vice-president, W. A. WILSON; secretary, C. J. ULRICH; treasurer, L. H. KREBS.

W. W. JOURDIN, formerly chief engineer of the power-plant of the Chino Copper Co., at Hurley, New Mexico, has gone to Miami, Arizona, where he will have charge of the joint power-plant of the Inspiration Consolidated Copper Co. and the International Smelting Company.

At the annual meeting of the Montana Society of Engineers the following officers were elected: president, MARTIN H. GERRY, Jr., Helena; first vice-president, ARTHUR W. RICHTER, Bozeman; second vice-president, JAMES H. KYD, Butte; secretary and librarian, CLINTON H. MOORE, Butte; treasurer and member of board of managers for Association of Engineering Societies, SAMUEL BARKER, Jr., Butte; trustee for three years, FRANCIS T. DONAHUE, Butte.

Obituary

MORTON L. TOWER, for the past three years engineer in charge of jetty construction at Humboldt bay, California, died at Eureka, April 17, of injuries received as the result of an accident two days before while inspecting the work.

F. HOPKINSON SMITH, almost equally noted as author, engineer, and artist, died in New York, April 7. His best known engineering achievements were in connection with the construction of a number of light-houses on Long Island Sound during the seventies.

Commercial Paragraphs

The HOLT MANUFACTURING CO. has recently completed extensive additions to its plant at Stockton.

The WASHINGTON PAVING CO., of Tacoma, has purchased the entire equipment of the ATLAS CONSTRUCTION CO., of Everett.

Richard P. Harvey has opened an office in the Monadnock building, San Francisco. He will represent the CONCRETE FORM CO., INC., of Syracuse, New York, manufacturers of the Whalen form for culverts. Mr. Harvey was formerly connected with the Wheeling Corrugating Co. of New York.

The People's Ice Co., of Fresno, has placed an order with the ALLIS-CHALMERS MANUFACTURING CO., through the San Francisco district office, for two 180-hp. 2-cylinder duplex 16 by 24 Diesel engines. These engines are to operate on crude oil at a speed of 225 r.p.m., and will be belted to two Arctic ice machines.

Catalogues Received

'Witte Engines,' the WITTE ENGINE WORKS, Kansas City, Missouri. P. 36. Illustrated. Describes the gas and oil engines manufactured by the company.

'Alberger Spiroflo Surface Condensers' and 'Tubular Heaters,' C. F. BRAUN & CO., San Francisco. These are two four-page illustrated bulletins describing the machinery named in their titles.

'Byron Jackson Pumps,' the BYRON JACKSON IRON WORKS, INC., San Francisco. P. 48. Illustrated. Describes the centrifugal pumps manufactured by the company and gives a number of useful hydraulic tables.

'Conglomerate Ore,' Bulletin No. 112, the WILLIAMS PATENT CRUSHER & PULVERIZER CO., St. Louis, Missouri. P. 8. Illustrated. Describes and gives records of performance of the conglomerate-ore crusher manufactured by the company.

'Symons Disc Crushers,' and 'Modern Crushing Machinery,' CHALMERS & WILLIAMS, INC., Chicago Heights, Illinois. P. 24 and 16, respectively. Illustrated. These two small bulletins describe different rock-crushers manufactured by the company.

'Otis Gravity Spiral Conveyors,' the OTIS ELEVATOR CO., New York and San Francisco. P. 56. Illustrated. Describes the spiral conveyors manufactured by the company for handling package goods, and gives data regarding several typical installations.

'The Peterson Power Plant Oil Filter,' the RICHARDSON-PHENIX CO., Milwaukee, Wisconsin. P. 32. Illustrated. Describes the construction and operation of this oil-filter, including curves showing results of tests made on oil taken from these filters and a number of photographs of plants where these filters are now operating.

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